

# **BIOS and Kernel Developer's Guide (BKDG) for AMD Family 15h Models 30h-3Fh Processors**

© 2013,2014 Advanced Micro Devices, Inc. All rights reserved.

The information contained herein is for informational purposes only, and is subject to change without notice. While every precaution has been taken in the preparation of this document, it may contain technical inaccuracies, omissions and typographical errors, and AMD is under no obligation to update or otherwise correct this information. Advanced Micro Devices, Inc. makes no representations or warranties with respect to the accuracy or completeness of the contents of this document, and assumes no liability of any kind, including the implied warranties of noninfringement, merchantability or fitness for particular purposes, with respect to the operation or use of AMD hardware, software or other products described herein. No license, including implied or arising by estoppel, to any intellectual property rights is granted by this document. Terms and limitations applicable to the purchase or use of AMD's products are as set forth in a signed agreement between the parties or in AMD's Standard Terms and Conditions of Sale.

### Trademarks

AMD, the AMD Arrow logo, and combinations thereof are trademarks of Advanced Micro Devices, Inc. Other product names used in this publication are for identification purposes only and may be trademarks of their respective companies.

HDMI is a trademark of HDMI Licensing, LLC.

HyperTransport is a licensed trademark of the HyperTransport Technology Consortium.

Microsoft is a registered trademark of Microsoft Corporation.

MMX is a trademark of Intel Corporation.

PCI Express and PCIe are registered trademarks of PCI-Special Interest Group (PCI-SIG).

### Dolby Laboratories, Inc.

Manufactured under license from Dolby Laboratories.

### Rovi Corporation

This device is protected by U.S. patents and other intellectual property rights. The use of Rovi Corporation's copy protection technology in the device must be authorized by Rovi Corporation and is intended for home and other limited pay-per-view uses only, unless otherwise authorized in writing by Rovi Corporation.

Reverse engineering or disassembly is prohibited.

USE OF THIS PRODUCT IN ANY MANNER THAT COMPLIES WITH THE MPEG ACTUAL OR DE FACTO VIDEO AND/OR AUDIO STANDARDS IS EXPRESSLY PROHIBITED WITHOUT ALL NECESSARY LICENSES UNDER APPLICABLE PATENTS. SUCH LICENSES MAY BE ACQUIRED FROM VARIOUS THIRD PARTIES INCLUDING, BUT NOT LIMITED TO, IN THE MPEG PATENT PORTFOLIO, WHICH LICENSE IS AVAILABLE FROM MPEG LA, L.L.C., 6312 S. FIDDLERS GREEN CIRCLE, SUITE 400E, GREENWOOD VILLAGE, COLORADO 80111.

# Table of Contents

<b>1</b>	<b>Overview</b>	<b>18</b>
1.1	Intended Audience	18
1.2	Reference Documents	18
1.3	Conventions	18
1.3.1	Numbering	18
1.3.2	Arithmetic And Logical Operators	19
1.3.3	Operator Precedence and Associativity	20
1.4	Definitions	20
1.5	Changes Between Revisions and Product Variations	25
1.5.1	Revision Conventions	25
1.5.2	Major Changes	26
1.5.2.1	Major Changes to Core/NB Performance Counters	27
<b>2</b>	<b>Functional Description</b>	<b>28</b>
2.1	Processor Overview	28
2.2	System Overview	29
2.3	Processor Initialization	29
2.3.1	BSC Initialization	30
2.3.2	AP Initialization	30
2.3.3	Using L2 Cache as General Storage During Boot	30
2.4	Core	32
2.4.1	Compute Unit	32
2.4.2	Caches and TLBs	33
2.4.2.1	Registers Shared by Cores in a Compute Unit	33
2.4.3	Virtual Address Space	34
2.4.4	Processor Cores and Downcoring	34
2.4.4.1	Software Downcoring using D18F3x190[DisCore]	34
2.4.5	Physical Address Space	35
2.4.6	System Address Map	35
2.4.6.1	Memory Access to the Physical Address Space	35
2.4.6.1.1	Determining Memory Type	35
2.4.6.1.2	Determining The Access Destination for Core Accesses	36
2.4.7	Timers	36
2.4.8	Implicit Conditions for TLB Invalidation	36
2.4.9	Interrupts	37
2.4.9.1	Local APIC	37
2.4.9.1.1	Detecting and Enabling	37
2.4.9.1.2	APIC Register Space	37
2.4.9.1.3	ApicId Enumeration Requirements	37
2.4.9.1.4	Physical Destination Mode	38
2.4.9.1.5	Logical Destination Mode	38
2.4.9.1.6	Interrupt Delivery	38
2.4.9.1.7	Vectored Interrupt Handling	38
2.4.9.1.8	Interrupt Masking	39
2.4.9.1.9	Spurious Interrupts	39
2.4.9.1.10	Spurious Interrupts Caused by Timer Tick Interrupt	39
2.4.9.1.11	Lowest-Priority Interrupt Arbitration	39
2.4.9.1.12	Inter-Processor Interrupts	40

2.4.9.1.13	APIC Timer Operation	40
2.4.9.1.14	Generalized Local Vector Table	40
2.4.9.1.15	State at Reset	40
2.4.9.2	System Management Mode (SMM)	41
2.4.9.2.1	SMM Overview	41
2.4.9.2.2	Operating Mode and Default Register Values	41
2.4.9.2.3	SMI Sources And Delivery	42
2.4.9.2.4	SMM Initial State	42
2.4.9.2.5	SMM Save State	43
2.4.9.2.6	Exceptions and Interrupts in SMM	48
2.4.9.2.7	The Protected ASeg and TSeg Areas	48
2.4.9.2.8	SMM Special Cycles	48
2.4.9.2.9	Locking SMM	49
2.4.9.2.10	Synchronizing SMM Entry (Spring-Boarding)	49
2.4.10	Secure Virtual Machine Mode (SVM)	50
2.4.10.1	BIOS support for SVM Disable	50
2.4.11	CPUID Instruction	51
2.4.11.1	Multi-Core Support	51
2.5	Power Management	52
2.5.1	Processor Power Planes And Voltage Control	52
2.5.1.1	Serial VID Interface	52
2.5.1.1.1	SVI2 Features	52
2.5.1.2	Internal VID Registers and Encodings	53
2.5.1.2.1	MinVid and MaxVid Check	53
2.5.1.3	Low Power Features	53
2.5.1.3.1	PSIx_L Bit	53
2.5.1.3.1.1	BIOS Requirements for PSIO_L	53
2.5.1.3.2	Low Power Voltages	55
2.5.1.4	Voltage Transitions	55
2.5.1.4.1	Hardware-Initiated Voltage Transitions	55
2.5.1.4.2	Software-Initiated Voltage Transitions	55
2.5.1.4.2.1	Software-Initiated NB Voltage Transitions	55
2.5.2	Frequency and Voltage Domain Dependencies	56
2.5.2.1	Dependencies Between Cores	56
2.5.2.2	Dependencies Between Subcomponents on VDDNB	56
2.5.2.3	BIOS Requirements for Power Plane Initialization	56
2.5.3	CPU Power Management	56
2.5.3.1	Core P-states	56
2.5.3.1.1	Core P-state Naming and Numbering	57
2.5.3.1.1.1	Software P-state Numbering	57
2.5.3.1.1.2	Hardware P-state Numbering	58
2.5.3.1.2	Core P-state Control	58
2.5.3.1.3	Core P-state Visibility	59
2.5.3.1.4	Core P-state Limits	59
2.5.3.1.5	Core P-state Transition Behavior	60
2.5.3.1.6	BIOS Requirements for Core P-state Initialization and Transitions	60
2.5.3.1.7	Processor-Systemboard Power Delivery Compatibility Check	61
2.5.3.1.8	BIOS COF and VID Requirements After Warm Reset	62
2.5.3.1.8.1	Core Maximum P-state Transition Sequence After Warm Reset	63
2.5.3.1.8.2	Core Minimum P-state Transition Sequence After Warm Reset	63
2.5.3.1.8.3	ACPI Processor P-state Objects	63

2.5.3.1.8.4	Fixed ACPI Description Table (FADT) Entries	65
2.5.3.1.8.5	XPSS (Microsoft Extended PSS) Object	65
2.5.3.2	Core C-states	65
2.5.3.2.1	C-state Names and Numbers	65
2.5.3.2.2	C-state Request Interface	66
2.5.3.2.3	C-state Actions	66
2.5.3.2.3.1	C-state Probes and Cache Flushing	66
2.5.3.2.3.2	Core C1 (CC1) State	66
2.5.3.2.3.3	Core C6 (CC6) State	66
2.5.3.2.3.4	Package C6 (PC6) State	67
2.5.3.2.4	C-state Request Monitors	67
2.5.3.2.4.1	FCH Messaging	67
2.5.3.2.4.2	Cache Flush On Halt Saturation Counter	68
2.5.3.2.5	Exiting C-states	68
2.5.3.2.6	ACPI Processor C-state Objects	68
2.5.3.2.6.1	_CST	68
2.5.3.2.6.2	_CSD	69
2.5.3.2.6.3	_CRS	69
2.5.3.2.6.4	Fixed ACPI Description Table (FADT) Entries	69
2.5.3.2.7	BIOS Requirements for Initialization	69
2.5.3.3	Effective Frequency	69
2.5.4	NB Power Management	70
2.5.4.1	NB P-states	70
2.5.4.1.1	Northbridge Dynamic Power Management (NB DPM)	70
2.5.4.1.2	NB P-state Transitions	70
2.5.4.1.3	BIOS NB P-state Configuration	71
2.5.4.1.3.1	NB P-state COF and VID Synchronization After Warm Reset	71
2.5.4.1.3.2	NB P-state Transitions	72
2.5.4.1.3.3	NB P-state Configuration for Runtime	72
2.5.4.2	NB C-states	72
2.5.4.3	Fuse Power Gating	73
2.5.5	Bandwidth Requirements	73
2.5.6	GPU and Root Complex Power Management	73
2.5.6.1	Dynamic Power Management (DPM)	73
2.5.6.1.1	Activity Monitors	74
2.5.6.1.2	SCLK DPM	74
2.5.6.1.3	LCLK DPM	74
2.5.6.2	GPU and Root Complex Power Gating	74
2.5.7	DRAM Power Management	75
2.5.7.1	Memory P-states	75
2.5.7.2	DRAM Self-Refresh	75
2.5.7.3	Stutter Mode	76
2.5.7.3.1	System BIOS Requirements for Stutter Mode Operation During POST	76
2.5.7.4	EVENT_L	76
2.5.8	System Power Management	76
2.5.8.1	S-states	76
2.5.8.1.1	ACPI Suspend to RAM State (S3)	77
2.5.9	Application Power Management (APM)	77
2.5.9.1	Core Performance Boost (CPB)	77
2.5.9.1.1	C-state Boost	78
2.5.9.2	TDP Limiting	78

2.5.9.3	Bidirectional Application Power Management (BAPM)	78
2.5.9.4	Configurable TDP (cTDP)	78
2.6	Performance Monitoring	79
2.6.1	Performance Monitor Counters	79
2.6.1.1	Core Performance Monitor Counters	79
2.6.1.2	NB Performance Monitor Counters	80
2.6.2	Instruction Based Sampling (IBS)	81
2.7	Configuration Space	81
2.7.1	MMIO Configuration Coding Requirements	82
2.7.2	MMIO Configuration Ordering	82
2.7.3	Processor Configuration Space	82
2.8	Northbridge (NB)	83
2.8.1	NB Architecture	83
2.8.2	NB Routing	83
2.8.2.1	Address Space Routing	83
2.8.2.1.1	DRAM and MMIO Memory Space	83
2.8.2.1.2	IO Space	84
2.8.2.1.3	Configuration Space	84
2.8.2.1.3.1	Recommended Buffer Count Settings Overview	85
2.8.3	Memory Scrubbers	85
2.9	DRAM Controllers (DCTs)	86
2.9.1	Common DCT Definitions	86
2.9.2	DCT Frequency Support	87
2.9.3	DCT Configuration Registers	89
2.9.4	DDR Pad to Processor Pin Mapping	90
2.9.4.1	DDR Chip to Pad Mapping	91
2.9.5	DRAM Controller Direct Response Mode	92
2.9.6	DRAM Data Burst Mapping	93
2.9.7	SOC Specific Definitions	94
2.9.8	PMU	94
2.9.8.1	mboxUSPend	94
2.9.8.2	mboxUS2Pend	95
2.9.8.3	SRAM Message Block	95
2.9.9	DCT/DRAM Initialization and Resume	100
2.9.9.1	Low Voltage	101
2.9.9.2	DDR Phy Initialization	101
2.9.9.2.1	Phy General Configuration	101
2.9.9.2.2	Phy Voltage Level Programming	102
2.9.9.2.3	DRAM Channel Frequency	102
2.9.9.2.4	DRAM CAD Bus Configuration	103
2.9.9.2.5	DRAM Data Bus Configuration	108
2.9.9.2.6	Phy FIFO Configuration	114
2.9.9.2.7	Phy Predriver Initialization	115
2.9.9.2.8	Phy Auto-Calibration	118
2.9.9.2.8.1	One-Time Pre-PMU Calibration	118
2.9.9.2.8.2	Fence CalOnce	118
2.9.9.2.8.3	Auto Calibration	118
2.9.9.2.9	PMU Firmware Load	118
2.9.9.2.10	Phy Registers Required for S3 Resume	119
2.9.9.2.11	Calculating Round Trip Command Delays	119
2.9.9.3	SPD ROM-Based Configuration	119

2.9.9.3.1	DRAM ODT Pin Control	120
2.9.9.4	DCT Specific Configuration	120
2.9.9.4.1	DDR3 Turnaround Parameters	121
2.9.9.4.1.1	TrdrdBan, TrdrdSdSc, TrdrdSdDc, and TrdrdDd (Rd->Rd Timing)	121
2.9.9.4.1.2	TwrrwrSdSc, TwrrwrSdDc, TwrrwrDd (Wr->Wr Timing)	121
2.9.9.4.1.3	Twrrd (Write to Read DIMM Termination Turn-around)	122
2.9.9.4.1.4	TrwtTO (Read-to-Write Turnaround for Data, DQS Contention)	122
2.9.9.5	DRAM Device Initialization and Training	122
2.9.9.6	DRAM Training	123
2.9.9.6.1	Training MaxRdLatency	123
2.9.9.7	Synchronous Channel Initialization	123
2.9.9.8	DRAM Channel Disable	124
2.9.9.9	DRAM Phy Power Savings	124
2.9.10	Continuous Pattern Generation	126
2.9.10.1	DCT Training Pattern Generation	126
2.9.10.1.1	Activate and Precharge Command Generation	126
2.9.10.1.2	Read and Write Command Generation	127
2.9.10.1.3	Data Comparison	128
2.9.10.1.4	BubbleCnt and CmdStreamLen Programming	128
2.9.11	Memory Interleaving Modes	129
2.9.11.1	Chip Select Interleaving	130
2.9.11.2	Channel Interleaving	132
2.9.11.2.1	Four Channel Interleaving	132
2.9.12	Memory Hoisting	132
2.9.12.1	DramHoleOffset Programming	132
2.9.12.2	DctSelBaseOffset Programming	134
2.9.13	DRAM CC6/PC6 Storage	136
2.9.13.1	Fixed Storage	136
2.9.14	DRAM On DIMM Thermal Management and Power Capping	137
2.10	Thermal Functions	139
2.10.1	The Tctl Temperature Scale	139
2.10.2	Temperature Slew Rate Control	140
2.10.3	Temperature-Driven Logic	140
2.10.3.1	PROCHOT_L and Hardware Thermal Control (HTC)	140
2.10.3.2	Software P-state Limit Control	141
2.10.3.3	THERMTRIP	141
2.11	Root Complex	142
2.11.1	Overview	142
2.11.2	Interrupt Routing	143
2.11.2.1	IOAPIC Configuration	143
2.11.3	Links	144
2.11.3.1	Overview	144
2.11.3.2	Link Configurations	144
2.11.4	Root Complex Configuration	146
2.11.4.1	LPC MMIO Requirements	146
2.11.4.2	Configuration for non-FCH Bridges	146
2.11.4.3	Link Configuration and Initialization	146
2.11.4.3.1	Link Configuration and Core Initialization	147
2.11.4.3.2	Link Training	147
2.11.4.4	Miscellaneous Features	147
2.11.4.4.1	Lane Reversal	147

2.11.4.4.2	Link Speed Changes	148
2.11.4.4.2.1	Autonomous Link Speed Changes	148
2.11.4.4.3	Deemphasis	148
2.11.4.5	Link Power Management	148
2.11.4.5.1	Link States	148
2.11.4.5.2	Dynamic Link-width Control	148
2.11.4.6	Link Test and Debug Features	149
2.11.4.6.1	Compliance Mode	149
2.11.5	FCH Messages	149
2.11.6	BIOS Timer	149
2.11.7	PCIe Client Interface Control	149
2.12	IOMMU	151
2.12.1	IOMMU Configuration Space	151
2.12.2	IOMMU Initialization	151
2.12.2.1	IOMMU L1 Initialization	151
2.12.2.2	IOMMU L2 Initialization	152
2.12.2.3	IOMMU SMI Filtering	152
2.13	System Management Unit (SMU)	153
2.13.1	Software Interrupts	153
2.14	Graphics Processor (GPU)	153
2.14.1	Graphics Memory Controller (GMC)	153
2.14.2	Frame Buffer (FB)	154
2.15	RAS Features	155
2.15.1	Machine Check Architecture	155
2.15.1.1	Machine Check Registers	155
2.15.1.2	Machine Check Errors	156
2.15.1.3	Error Detection, Action, Logging, and Reporting	157
2.15.1.3.1	MCA conditions that cause Shutdown	158
2.15.1.3.2	Error Logging During Overflow	158
2.15.1.4	MCA Initialization	159
2.15.1.5	Error Code	160
2.15.1.6	Handling Machine Check Exceptions	161
2.15.1.6.1	Differentiation Between System-Fatal and Process-Fatal Errors	163
2.15.1.7	Error Thresholding	164
2.15.1.8	Scrub Rate Considerations	165
2.15.1.9	Error Diagnosis	166
2.15.1.9.1	Common Diagnosis Information	167
2.15.1.10	Deferred Errors and Data Poisoning	168
2.15.2	DRAM ECC Considerations	169
2.15.2.1	ECC Syndromes	169
2.15.2.1.1	x4 ECC	169
2.15.3	Error Injection and Simulation	171
2.15.3.1	DRAM Error Injection	171
2.15.4	GIO RAS	172
<b>3</b>	<b>Registers</b>	<b>173</b>
3.1	Register Descriptions and Mnemonics	173
3.1.1	Northbridge MSRs In Multi-Core Products	175
3.1.2	Software Recommendation (BIOS, SBIOS)	175
3.1.3	See Keyword (See:)	176
3.1.4	Mapping Tables	176



3.1.4.1	Register Mapping	176
3.1.4.2	Index Mapping	176
3.1.4.3	Field Mapping	176
3.1.4.4	Broadcast Mapping	176
3.1.4.5	Reset Mapping	177
3.1.4.6	Valid Values	177
3.1.4.7	BIOS Recommendations	177
3.2	IO Space Registers	177
3.3	Device 0 Function 0 (Root Complex) Configuration Registers	179
3.4	Device 0 Function 2 (IOMMU) Configuration Registers	234
3.5	Device 1 Function 0 (Internal Graphics) Configuration Registers	269
3.6	Device 1 Function 1 (Audio Controller) Configuration Registers	281
3.7	Device [4:2] Function 0 (Host Bridge) Configuration Registers	292
3.8	Device [4:2] Function [5:1] (Root Port) Configuration Registers	293
3.9	Device 18h Function 0 Configuration Registers	326
3.10	Device 18h Function 1 Configuration Registers	339
3.11	Device 18h Function 2 Configuration Registers	354
3.12	Device 18h Function 3 Configuration Registers	439
3.13	Device 18h Function 4 Configuration Registers	476
3.14	Device 18h Function 5 Configuration Registers	485
3.15	Northbridge IOAPIC Registers	500
3.16	IOMMU Memory Mapped Registers	502
3.17	APIC Registers	520
3.18	CPUID Instruction Registers	530
3.19	MSRs - MSR0000_0xxx	561
3.20	MSRs - MSRC000_0xxx	607
3.21	MSRs - MSRC001_0xxx	615
3.22	MSRs - MSRC001_1xxx	644
3.23	Core Performance Counter Events	664
3.23.1	PMCx0[1F:00] Events (FP)	664
3.23.2	PMCx0[3F:20] Events (LS)	665
3.23.3	PMCx0[5F:40] Events (DC)	667
3.23.4	PMCx[1:0][7F:60] Events (CU)	670
3.23.5	PMCx[1:0][9F:80] Events (IC)	674
3.23.6	PMCx[1,0][DF:C0] Events (EX, DE)	677
3.24	NB Performance Counter Events	682
3.24.1	PMCx0E[7:4] Events (Memory Controller)	682
3.24.2	PMCx0E[F:8] Events (Crossbar)	682
3.24.3	PMCx0F[F:0] Events (Crossbar)	685
3.24.4	NBPMCx1E[F:0] Events (Crossbar)	685
3.24.5	NBPMCx1F[F:0] Events (Memory Controller, Crossbar)	688
3.24.6	3F[F:0] Events (Memory Controller)	690
<b>4</b>	<b>Register List</b>	<b>693</b>

# List of Figures

Figure 1:	A Compute Unit.....	29
Figure 2:	A processor .....	29
Figure 3:	Memory Configuration with Memory Hole inside of Region .....	133
Figure 4:	Memory Configuration with Memory Hole outside of Region .....	134
Figure 5:	2 DCT Channel Interleaved .....	135
Figure 6:	2 DCT Channel Interleaved with Memory Hole.....	136
Figure 7:	Tctl scale .....	139
Figure 8:	Root complex topology.....	142
Figure 9:	Phy recovered clock and sample clock .....	208

# List of Tables

Table 1:	Arithmetic and Logical Operators.....	19
Table 2:	Functions.....	19
Table 3:	Operator Precedence and Associativity .....	20
Table 4:	Definitions.....	20
Table 5:	Processor revision conventions.....	26
Table 6:	Compute Unit Definitions.....	32
Table 7:	SMM Initial State.....	42
Table 8:	SMM Save State.....	43
Table 9:	Power Management Support.....	52
Table 10:	Software P-state Naming .....	58
Table 11:	Software P-state Control .....	59
Table 12:	Core PMC mapping to PERF_CTL[5:0] .....	80
Table 13:	ONION Link Definitions .....	85
Table 14:	DCT Channel Ctrl Map.....	86
Table 15:	DCT Definitions.....	86
Table 16:	DDR3 UDIMM Maximum Frequency Support for FM2r2 package.....	88
Table 17:	DDR3 UDIMM Maximum Frequency Support for FP3 package.....	88
Table 18:	DDR3 SODIMM Maximum Frequency Support for FM2r2 package.....	88
Table 19:	DDR3 SODIMM Maximum Frequency Support for FP3 package .....	89
Table 20:	Package pin mapping .....	90
Table 21:	DDR Chip to pad mapping (DDR3 Mode) .....	91
Table 22:	DCT Definitions.....	94
Table 23:	US Mailbox 1 Messages for DDR3 .....	94
Table 24:	SRAM Message Block for DDR3.....	95
Table 25:	BIOS Recommendations for DDR3 SO-DIMM CAD bus configuration .....	103
Table 26:	BIOS Recommendations for DDR3 UDIMM CAD bus configuration.....	106
Table 27:	BIOS Recommendations for DDR3 SO-DIMM data bus configuration .....	109
Table 28:	BIOS Recommendations for DDR3 UDIMM data bus configuration.....	111
Table 29:	BIOS Recommendations for DDR3 FIFO RdPtrInitVal for NbP0.....	115
Table 30:	BIOS Recommendations for DDR3 FIFO RdPtrInitVal for NbPx.....	115
Table 31:	Phy predriver codes for Data/DQS .....	116
Table 32:	Phy predriver codes for Cmd/Addr.....	117
Table 33:	Phy predriver codes for CLK.....	117
Table 34:	DDR3 DIMM ODT Pattern .....	120
Table 35:	DCT Training Specific Register Values.....	120
Table 36:	Command Generation and Data Comparison .....	128
Table 37:	DDR3 Command Generation and BubbleCnt Programming.....	129
Table 38:	Recommended Interleave Configurations.....	130
Table 39:	DDR3 Swapped Normalized Address Lines for CS Interleaving.....	130
Table 40:	Example storage region configuration .....	137
Table 41:	Recommended Interrupt Routing and Swizzling Configuration.....	143
Table 42:	Supported Gfx Port Configurations .....	144

Table 43:	Supported DP0/DP1 DDI Link Configurations .....	145
Table 44:	Supported General Purpose (GPP) Link Configurations .....	145
Table 45:	SMU Software Interrupts .....	153
Table 46:	Recommended Frame Buffer Configurations .....	154
Table 47:	MCA register cross-reference table .....	156
Table 48:	Overwrite Priorities for All Banks .....	159
Table 49:	Error Code Types .....	160
Table 50:	Error codes: transaction type (TT) .....	160
Table 51:	Error codes: cache level (LL) .....	160
Table 52:	Error codes: memory transaction type (RRRR) .....	161
Table 53:	Error codes: participation processor (PP) .....	161
Table 54:	Error codes: memory or IO (II) .....	161
Table 55:	Error codes: Internal Error Type (UU) .....	161
Table 56:	Error Scope Hierarchy .....	163
Table 57:	Recommended Scrub Rates per Node .....	166
Table 58:	Registers Commonly Used for Diagnosis .....	167
Table 59:	x4 ECC Correctable Syndromes .....	170
Table 60:	Terminology in Register Descriptions .....	174
Table 61:	Reset values for D0F0x64_x3[B:0] .....	184
Table 62:	Register Mapping for D0F0xBC_x3FD[8C:00:step14] .....	194
Table 63:	Register Mapping for D0F0xBC_x3FD[94:08:step14] .....	194
Table 64:	Register Mapping for D0F0xBC_x3FD[9C:10:step14] .....	194
Table 65:	Mapping for PIF registers .....	201
Table 66:	Index addresses for D0F0xE4_x0[210,11[3:0]]_001[8:7,3:2] .....	202
Table 67:	Per phy register addresses to pin mappings .....	204
Table 68:	Per nibble register addresses to pin mappings .....	204
Table 69:	Index Mapping for D0F0xE4_x0[220,123:120]_0000 .....	204
Table 70:	Recommended Ron settings .....	205
Table 71:	Index Mapping for D0F0xE4_x0[220,123:120]_000[2:1] .....	205
Table 72:	Index Mapping for D0F0xE4_x0[220,123:120]_000[C:B] .....	207
Table 73:	Phy per receiver lane register addresses .....	208
Table 74:	Phy receiver broadcast register addresses .....	208
Table 75:	Index Mapping for D0F0xE4_x0[220,123:120]_[5:4][7:6,3:0][8,0]2 .....	209
Table 76:	Broadcast Mapping for D0F0xE4_x0[220,123:120]_[5:4][7:6,3:0][8,0]2 .....	209
Table 77:	Index Mapping for D0F0xE4_x0[220,123:120]_[5:4][7:6,3:0][8,0]5 .....	210
Table 78:	Broadcast Mapping for D0F0xE4_x0[220,123:120]_[5:4][7:6,3:0][8,0]5 .....	210
Table 79:	BIOS Recommendations for D0F0xE4_x0[220,123:120]_[5:4][7:6,3:0][8,0]6[VdcDac] .....	211
Table 80:	Index Mapping for D0F0xE4_x0[220,123:120]_[5:4][7:6,3:0][8,0]6 .....	212
Table 81:	Broadcast Mapping for D0F0xE4_x0[220,123:120]_[5:4][7:6,3:0][8,0]6 .....	212
Table 82:	Index Mapping for D0F0xE4_x0[220,123:120]_[5:4][7:6,3:0][8,0]A .....	212
Table 83:	Broadcast Mapping for D0F0xE4_x0[220,123:120]_[5:4][7:6,3:0][8,0]A .....	213
Table 84:	Phy per transmitter lane register addresses .....	213
Table 85:	Phy transmitter broadcast register addresses .....	213
Table 86:	Index Mapping for D0F0xE4_x0[220,123:120]_[7:6][7:6,3:0][8,0]0 .....	214

Table 87:	Broadcast Mapping for D0F0xE4_x0[220,123:120]_[7:6][7:6,3:0][8,0]0 .....	214
Table 88:	Recommended preemphasis settings .....	215
Table 89:	Index Mapping for D0F0xE4_x0[220,123:120]_[7:6][7:6,3:0][8,0]6 .....	215
Table 90:	Broadcast Mapping for D0F0xE4_x0[220,123:120]_[7:6][7:6,3:0][8,0]6 .....	215
Table 91:	BIOS Recommendations for GangedModeEn, IsOwnMstr .....	216
Table 92:	Index Mapping for D0F0xE4_x0[220,123:120]_[F:E][7:0][8,0]6 .....	216
Table 93:	Broadcast Mapping for D0F0xE4_x0[220,123:120]_[F:E][7:0][8,0]6 .....	216
Table 94:	Mapping for wrapper registers .....	218
Table 95:	Index address mapping for D0F0xE4_x013[2:0]_0[C:8]00 .....	218
Table 96:	Index address mapping for D0F0xE4_x013[2:0]_0[C:8]03 .....	219
Table 97:	Reserved field mappings for D0F0xE4_x013[3:0]_8013 .....	220
Table 98:	Reserved field mappings for D0F0xE4_x013[3:0]_8014 .....	221
Table 99:	Lane index addresses for D0F0xE4_x013[3:0]_802[4:1] .....	223
Table 100:	Reset Mapping for D0F0xE4_x013[3:0]_802[4:1] .....	223
Table 101:	Field mapping for D0F0xE4_x013[3:0]_802[4:1] .....	223
Table 102:	Lane index addresses for D0F0xE4_x013[3:0]_802[8:5] .....	224
Table 103:	Reset Mapping for D0F0xE4_x013[3:0]_802[8:5] .....	224
Table 104:	Field mapping for D0F0xE4_x013[3:0]_802[8:5] .....	224
Table 105:	Index address mapping for D0F0xE4_x013[3:0]_804[3:0] .....	225
Table 106:	Register mappings for D0F0xE4_x013[3:0]_804[E:8] .....	226
Table 107:	Reserved field mappings for D0F0xE4_x013[3:0]_8060 .....	227
Table 108:	Mapping for IO link registers .....	228
Table 109:	Valid Values for D0F2xFC_x20_L1i[4:0] .....	265
Table 110:	Register Mapping for D[4:2]F[5:1]x00 .....	293
Table 111:	Reset Mapping for D[4:2]F[5:1]x00 .....	293
Table 112:	Link controller state encodings .....	316
Table 113:	Register Mapping for D18F0x[5C:40] .....	327
Table 114:	Register Mapping for D18F0x[E4,C4,A4,84] .....	331
Table 115:	Register Mapping for D18F0x[EC,CC,AC,8C] .....	332
Table 116:	Register Mapping for D18F0x[F0,D0,B0,90] .....	332
Table 117:	Link Buffer Definitions .....	333
Table 118:	Register Mapping for D18F0x[F4,D4,B4,94] .....	334
Table 119:	Register Mapping for D18F0x[F8,D8,B8,98] .....	335
Table 120:	Register Mapping for D18F0x[11C,118,114,110] .....	336
Table 121:	Register Mapping for D18F0x[18C:170] .....	337
Table 122:	Onion Definitions .....	337
Table 123:	Register Mapping for D18F1x[17C:140,7C:40] .....	339
Table 124:	Register Mapping for D18F1x[7:4][8,0] .....	340
Table 125:	Register Mapping for D18F1x1[7:4][8,0] .....	340
Table 126:	Register Mapping for D18F1x[7:4][C,4] .....	341
Table 127:	Register Mapping for D18F1x1[7:4][C,4] .....	341
Table 128:	Register Mapping for D18F1x[2CC:2A0,1CC:180,BC:80] .....	342
Table 129:	Register Mapping for D18F1x[2B:1A,B:8][8,0] .....	342
Table 130:	Register Mapping for D18F1x[2B:1A,B:8][C,4] .....	343

Table 131:	Register Mapping for D18F1x[2CC:2C0,1CC:1C0,19C:180]	344
Table 132:	Register Mapping for D18F1x[1F:1E,D:C][8,0]	345
Table 133:	Register Mapping for D18F1x[1F:1E,D:C][C,4]	346
Table 134:	Register Mapping for D18F1x[1DC:1D0,EC:E0]	347
Table 135:	Register Mapping for D18F1x2[1C:00]	351
Table 136:	Register Mapping for D18F1x2[1,0][8,0]	351
Table 137:	Register Mapping for D18F1x2[1,0][C,4]	352
Table 138:	Register Mapping for D18F1x2[4C:40]	353
Table 139:	DIMM, Chip Select, and Register Mapping	354
Table 140:	DDR3 DRAM Address Mapping	359
Table 141:	Valid Values for Memory Clock Frequency Value Definition	365
Table 142:	Index Mapping for D18F2x9C_x00[F,3:0]0_0009_dct[3:0]	367
Table 143:	Index Mapping for D18F2x9C_x0[3,1:0][F,3:0]0_0014_dct[3:0]	367
Table 144:	Index Mapping for D18F2x9C_x0[3,1:0][F,3:0]0_[F,3:0]028_dct[3:0]	368
Table 145:	Index Mapping for D18F2x9C_x00[F,3:0]0_[F,3:0][8,3:0]2E_dct[3:0]	368
Table 146:	Address Mapping for D18F2x9C_x0[3,1:0][F,3:0]0_[F,B:0]041_dct[3:0]	369
Table 147:	Index Mapping for D18F2x9C_x00[F,3:0]0_[F,B:0]04A_dct[3:0]	370
Table 148:	Index Mapping for D18F2x9C_x00[F,3:0]0_[F,B:0]04E_dct[3:0]	370
Table 149:	Index Mapping for D18F2x9C_x00[F,3:0]0_[F,B:0]05F_dct[3:0]	371
Table 150:	Address Mapping for D18F2x9C_x00[F,3:0]0_0077_dct[3:0]	371
Table 151:	Address Mapping for D18F2x9C_x00[F,3:0]0_0078_dct[3:0]	372
Table 152:	Index Mapping for D18F2x9C_x0[3,1:0][F,3:0]0_[F,3:0]081_dct[3:0]	372
Table 153:	Index Mapping for D18F2x9C_x00[F,8:0]1_0000_dct[3:0]	373
Table 154:	Index Mapping for D18F2x9C_x0[3,1:0][F,8:0]1_0014_dct[3:0]	373
Table 155:	Index Mapping for D18F2x9C_x00[F,8:0]1_0016_dct[3:0]	375
Table 156:	Index Mapping for D18F2x9C_x00[F,8:0]1_001C_dct[3:0]	376
Table 157:	Index Mapping for D18F2x9C_x0[3,1:0][F,8:0]1_0028_dct[3:0]	376
Table 158:	Index Mapping for D18F2x9C_x0[3,1:0][F,8:0]1_0029_dct[3:0]	377
Table 159:	Index Mapping for D18F2x9C_x0[3,1:0][F,8:0]1_002A_dct[3:0]	377
Table 160:	Index Mapping for D18F2x9C_x0[3,1:0][F,8:0]1_002B_dct[3:0]	378
Table 161:	Index Mapping for D18F2x9C_x0[3,1:0][F,8:0]1_002C_dct[3:0]	378
Table 162:	Index Mapping for D18F2x9C_x00[F,8:0]1_0[8,3:0]2E_dct[3:0]	378
Table 163:	Address Mapping for D18F2x9C_x0[3,1:0][F,8:0]1_[F,B:0]041_dct[3:0]	379
Table 164:	Address Mapping for D18F2x9C_x0[3,1:0][F,8:0]1_[F,7:0]043_dct[3:0]	380
Table 165:	Address Mapping for D18F2x9C_x0[3,1:0][F,8:0]1_[F,7:0]045_dct[3:0]	381
Table 166:	Address Mapping for D18F2x9C_x0[3,1:0][F,8:0]1_[F,B:0]046_dct[3:0]	382
Table 167:	Address Mapping for D18F2x9C_x0[3,1:0][F,8:0]1_[F,B:0]047_dct[3:0]	382
Table 168:	Address Mapping for D18F2x9C_x0[3,1:0][F,8:0]1_[F,B:0]048_dct[3:0]	383
Table 169:	Index Mapping for D18F2x9C_x00[F,8:0]1_[F,B:0]04A_dct[3:0]	383
Table 170:	Address Mapping for D18F2x9C_x0[3,1:0][F,8:0]1_[F,B:0]04D_dct[3:0]	384
Table 171:	Index Mapping for D18F2x9C_x00[F,8:0]1_[F,B:0]04E_dct[3:0]	385
Table 172:	Address Mapping for D18F2x9C_x00[F,8:0]1_[F,B:0]051_dct[3:0]	385
Table 173:	Address Mapping for D18F2x9C_x00[F,8:0]1_[F,B:0]05F_dct[3:0]	386
Table 174:	Address Mapping for D18F2x9C_x00[F,8:0]1_0[F,2:0]77_dct[3:0]	387

Table 175:	Address Mapping for D18F2x9C_x00[F,8:0]1_0[F,2:0]78_dct[3:0] .....	387
Table 176:	Address Mapping for D18F2x9C_x0[F,1:0][F,8:0]1_[F,9:0][F,3:0]80_dct[3:0] .....	388
Table 177:	Address Mapping for D18F2x9C_x0[F,1:0][F,8:0]1_[F,9:0][F,3:0]81_dct[3:0] .....	389
Table 178:	Index Mapping for PllMultDiv Value Definition .....	390
Table 179:	Index Mapping for D18F2x9C_x0[1:0]02_0080_dct[3:0] .....	394
Table 180:	BIOS Recommendations for D18F2x1B[4:0] .....	411
Table 181:	Field Mapping for D18F2x1BC_dct[3:0] .....	414
Table 182:	BIOS Recommendations for D18F2x1BC_dct[3:0] .....	414
Table 183:	Register Mapping for D18F2x25[8,4]_dct[3:0] .....	428
Table 184:	Buffer Definitions .....	449
Table 185:	SMAF Action Definition .....	453
Table 186:	Register Mapping for D18F3x1[54:48] .....	467
Table 187:	D18F5x80[Enabled, DualCore] Definition .....	486
Table 188:	Register Mapping for D18F5x16[C:0] .....	491
Table 189:	NB P-state Definitions .....	491
Table 190:	Register Mapping for IOMMUx[78,70,68,60] .....	509
Table 191:	Register Mapping for IOMMUx[7C,74,6C,64] .....	510
Table 192:	Register Mapping for IOMMUx4[1,0][3:0]00 .....	514
Table 193:	Register Mapping for IOMMUx4[1,0][3:0]04 .....	515
Table 194:	Register Mapping for IOMMUx4[1,0][3:0]08 .....	515
Table 195:	Register Mapping for IOMMUx4[1,0][3:0]10 .....	515
Table 196:	Register Mapping for IOMMUx4[1,0][3:0]14 .....	516
Table 197:	Register Mapping for IOMMUx4[1,0][3:0]18 .....	516
Table 198:	Register Mapping for IOMMUx4[1,0][3:0]1C .....	517
Table 199:	Register Mapping for IOMMUx4[1,0][3:0]20 .....	517
Table 200:	Register Mapping for IOMMUx4[1,0][3:0]24 .....	517
Table 201:	Register Mapping for IOMMUx4[1,0][3:0]28 .....	518
Table 202:	Register Mapping for IOMMUx4[1,0][3:0]2C .....	518
Table 203:	Register Mapping for APIC[170:100] .....	522
Table 204:	Register Mapping for APIC[1F0:180] .....	523
Table 205:	Register Mapping for APIC[270:200] .....	523
Table 206:	ICR valid combinations .....	524
Table 207:	Register Mapping for APIC3[60:50] .....	526
Table 208:	Div[3,1:0] Value Table .....	528
Table 209:	Register Mapping for APIC[4F0:480] .....	529
Table 210:	Register Mapping for APIC[530:500] .....	529
Table 211:	Reset Mapping for CPUID Fn8000_0000_E[D,C,B]X .....	530
Table 212:	CPUID Fn8000_0000_E[B,C,D]X Value .....	539
Table 213:	Valid Values for CPUID Fn8000_000[4:2]_E[D,C,B,A]X .....	542
Table 214:	ECX mapping to Cache Type for CPUID Fn8000_001D_E[D,C,B,A]X .....	554
Table 215:	Register Mapping for MSR0000_020[E,C,A,8,6,4,2,0] .....	565
Table 216:	Valid Values for Memory Type Definition .....	566
Table 217:	Register Mapping for MSR0000_020[F,D,B,9,7,5,3,1] .....	566
Table 218:	Register Mapping for MSR0000_02[6F:68,59:58,50] .....	567

Table 219:	Field Mapping for MSR0000_02[6F:68,59:58,50].....	567
Table 220:	MC0 Error Descriptions.....	571
Table 221:	MC0 Error Signatures.....	572
Table 222:	MC0 Address Register.....	573
Table 223:	MC1 Error Descriptions.....	577
Table 224:	MC1 Error Signatures.....	579
Table 225:	MC1 Address Register.....	580
Table 226:	MBE, SBU, and SBC Definitions.....	585
Table 227:	MC2 Error Descriptions.....	585
Table 228:	MC2 Error Signatures.....	587
Table 229:	MC2 Address Register.....	588
Table 230:	MC4 Error Descriptions.....	593
Table 231:	MC4 Error Signatures, Part 1.....	594
Table 232:	MC4 Error Signatures, Part 2.....	595
Table 233:	Format of MSR0000_0412[ErrAddr[47:1]] for All Other Errors.....	596
Table 234:	Format of MSR0000_0412[ErrAddr[47:1]] for Protocol Errors.....	596
Table 235:	Valid Values for ProtocolErrorType.....	596
Table 236:	Format of MSR0000_0412[ErrAddr[47:1]] for NB Array Errors.....	597
Table 237:	Valid Values for ArrayErrorType.....	597
Table 238:	Format of MSR0000_0412[ErrAddr[47:1]] for Watchdog Timer Errors.....	598
Table 239:	MC5 Error Descriptions.....	601
Table 240:	MC5 Error Signatures.....	602
Table 241:	MC5 Address Register.....	603
Table 242:	MC6 Error Descriptions.....	605
Table 243:	MC6 Error Signatures.....	606
Table 244:	Register Mapping for MSRC001_00[03:00].....	615
Table 245:	Register Mapping for MSRC001_00[07:04].....	615
Table 246:	Register Mapping for MSRC001_00[35:30].....	621
Table 247:	BIOS Recommendations for MSRC001_00[35:30].....	622
Table 248:	Register Mapping for MSRC001_00[53:50].....	626
Table 249:	Register Mapping for MSRC001_00[6B:64].....	630
Table 250:	P-state Definitions.....	631
Table 251:	Register Mapping for MSRC001_020[A,8,6,4,2,0].....	639
Table 252:	Register Mapping for MSRC001_020[B,9,7,5,3,1].....	641
Table 253:	Register Mapping for MSRC001_024[6,4,2,0].....	641
Table 254:	Register Mapping for MSRC001_024[7,5,3,1].....	642
Table 255:	Register Mapping for MSRC001_101[B:9].....	648
Table 256:	Field Mapping for MSRC001_101[B:9].....	648
Table 257:	Register Mapping for PMCx0D[F:C].....	680



# Revision History

KV BKDG Revision 3.01 Changes, Feb 19, 2014, PUB release

- [2.12.2.3 \[IOMMU SMI Filtering\]](#): Updated.
- [2.14.2 \[Frame Buffer \(FB\)\]](#): Updated.
- [2.15.1.3.2 \[Error Logging During Overflow\]](#): Table 48 Updated.
- [APIC300\[DS\]](#): Updated.
- [D0F0xBC\[NbSmuIndData\]](#): Updated.
- [D0F0xD4\[NbGbifIndData\]](#): Updated.
- [D0F2x70\[NxSupW\]](#): Updated.
- [D18F0x\[F0,D0,B0,90\] \[Link Base Channel Buffer Count\]](#): Updated.
- [D18F3x160 \[NB Machine Check Misc \(DRAM Thresholding\) 0 \(MC4\\_MISC0\)\]](#): Updated.
- [D18F5x16\[C:0\]\[NbDid\]](#): Updated.
- [D18F5x194\[Index\]](#): Updated.
- [D18F5x198\[Data\]](#): Updated.

KV BKDG Revision 3.00 Changes, Jan 10, 2014, Initial Public release

## 1 Overview

This document defines AMD Family 15h Models 30h-3Fh Processors, henceforth referred to as the processor.

- The processor overview is located at [2.1 \[Processor Overview\]](#).
- The processor is distinguished by the combined ExtFamily and BaseFamily fields of the CPUID instruction (see [CPUID Fn8000\\_0001\\_EAX](#) in [3.18 \[CPUID Instruction Registers\]](#)).

### 1.1 Intended Audience

This document provides the processor behavioral definition and associated design notes. It is intended for platform designers and for programmers involved in the development of low-level BIOS (basic input/output system) functions, drivers, and operating system kernel modules. It assumes prior experience in personal computer platform design, microprocessor programming, and legacy x86 and AMD64 microprocessor architecture. The reader should also have familiarity with various platform technologies, such as DDR DRAM.

### 1.2 Reference Documents

- Advanced Configuration and Power Interface (ACPI) Specification. [www.acpi.info](http://www.acpi.info).
- AMD64 Architecture Programmer's Manual Volume 1: Application Programming, #24592.
- AMD64 Architecture Programmer's Manual Volume 2: System Programming, #24593.
- AMD64 Architecture Programmer's Manual Volume 3: Instruction-Set Reference, #24594.
- AMD64 Architecture Programmer's Manual Volume 4: 128-Bit and 256-Bit Media Instructions, #26568.
- AMD64 Architecture Programmer's Manual Volume 5: 64-Bit Media and x87 Floating-Point Instructions, #26569.
- AMD I/O Virtualization Technology (IOMMU) Specification, #34434.
- Software Optimization Guide for AMD Family 15h Processors, #47414.
- Revision Guide for AMD Family 15h Models 30h-3Fh Processors, #51603.
- JEDEC standards. [www.jedec.org](http://www.jedec.org).
- PCI local bus specification. ([www.pcisig.org](http://www.pcisig.org)).
- PCI Express® specification. ([www.pcisig.org](http://www.pcisig.org)).
- AMD64 Technology Lightweight Profiling Specification, #43724.

### 1.3 Conventions

#### 1.3.1 Numbering

- **Binary numbers.** Binary numbers are indicated by appending a “b” at the end, e.g., 0110b.
- **Decimal numbers.** Unless specified otherwise, all numbers are decimal. This rule does not apply to the register mnemonics described in [3.1 \[Register Descriptions and Mnemonics\]](#); register mnemonics all utilize hexadecimal numbering.
- **Hexadecimal numbers.** hexadecimal numbers are indicated by appending an “h” to the end, e.g., 45f8h.
- **Underscores in numbers.** Underscores are used to break up numbers to make them more readable. They do not imply any operation. E.g., 0110\_1100b.

### 1.3.2 Arithmetic And Logical Operators

In this document, formulas generally follow Verilog conventions for logic equations.

**Table 1: Arithmetic and Logical Operators**

Operator	Definition
{}	Concatenation. Curly brackets are used to indicate a group of bits that are concatenated together. Each set of bits is separated by a comma. E.g., {Addr[3:2], Xlate[3:0]} represents a 6-bit value; the two MSBs are Addr[3:2] and the four LSB's are Xlate[3:0].
	Bitwise OR. E.g. (01b   10b == 11b).
	Logical OR. E.g. (01b    10b == 1b); treats multibit operand as 1 if >=1 and produces a 1-bit result.
&	Bitwise AND. E.g. (01b & 10b == 00b).
&&	Logical AND. E.g. (01b && 10b == 1b); logical treats multibit operand as 1 if >=1 and produces a 1-bit result.
^	Bitwise exclusive-OR. E.g. (01b ^ 10b == 11b). Sometimes used as “raised to the power of” as well, as indicated by the context in which it is used. E.g. (2^2 == 4).
~	Bitwise NOT. (also known as one's complement). E.g. (~10b == 01b).
!	Logical NOT. E.g. (!10b == 0b); treats multibit operand as 1 if >=1 and produces a 1-bit result.
<, <=, >, >=, ==, !=	Relational. Less than, Less than or equal, greater, greater than or equal, equal, and not equal.
+, -, *, /, %	Arithmetic. Addition, subtraction, multiplication, division, and modulus.
<<	Bitwise left shift. Shift left first operand by the number of bits specified by the 2nd operand. E.g. (01b << 01b == 10b).
>>	Bitwise right shift. Shift right first operand by the number of bits specified by the 2nd operand. E.g. (10b >> 01b == 01b).
?:	Ternary conditional. E.g. <i>condition ? value if true : value if false</i> . Equivalent to IF <i>condition</i> THEN <i>value if true</i> ELSE <i>value if false</i> .

**Table 2: Functions**

Function	Definition
ABS	ABS(integer-expression): Remove sign from signed value.
FLOOR	FLOOR(integer-expression): Rounds real number down to nearest integer.
CEIL	CEIL(real-expression): Rounds real number up to nearest integer.
MIN	MIN(integer-expression-list): Picks minimum integer or real value of comma separated list.
MAX	MAX(integer-expression-list): Picks maximum integer or real value of comma separated list.
COUNT	COUNT(integer-expression): Returns the number of binary 1's in the integer.

**Table 2: Functions**

Function	Definition
ROUND	ROUND(real-expression): Rounds to the nearest integer; halfway rounds away from zero.
UNIT	UNIT(fieldName UnitOfMeasure): Input operand is a register field name that defines all values with the same unit of measure. Returns the value expressed in the unit of measure for the current value of the register field.
POW	POW(base, exponent): POW(x,y) returns the value x to the power of y.

### 1.3.3 Operator Precedence and Associativity

This document follows C operator precedence and associativity. The following table lists operator precedence (highest to lowest). Their associativity indicates in what order operators of equal precedence in an expression are applied. Parentheses are also used to group sub-expressions to force a different precedence; such parenthetical expressions can be nested and are evaluated from inner to outer. E.g. “X = A | ~B & C” is the same as “X = A | ((~B) & C)”.

**Table 3: Operator Precedence and Associativity**

Operator	Description	Associativity
!, ~	Logical negation/bitwise complement	right-to-left
*, /, %	Multiplication/division/modulus	left-to-right
+, -	Addition/subtraction	left-to-right
<<, >>	Bitwise shift left, Bitwise shift right	left-to-right
<, <=, >, >=, ==, !=	Relational operators	left-to-right
&	Bitwise AND	left-to-right
^	Bitwise exclusive OR	left-to-right
	Bitwise inclusive OR	left-to-right
&&	Logical AND	left-to-right
	Logical OR	left-to-right
?:	Ternary conditional	right-to-left

## 1.4 Definitions

**Table 4: Definitions**

Term	Definition
AP	Application processor. See <a href="#">2.3 [Processor Initialization]</a> .
BAPM	Bidirectional Application Power Management. See <a href="#">2.5.9.3 [Bidirectional Application Power Management (BAPM)]</a> .
Battery-Power	The system is running from a battery power source or otherwise undocked from a continuous power supply. Setting using this definition may be required to change during runtime.
BCS	Base configuration space. See <a href="#">2.7 [Configuration Space]</a> .

**Table 4: Definitions**

Term	Definition
<b>BERT</b>	Bit error rate tester. A piece of test equipment that generates arbitrary test patterns and checks that a device under test returns them without errors.
<b>BIST</b>	Built-in self-test. Hardware within the processor that generates test patterns and verifies that they are stored correctly (in the case of memories) or received without error (in the case of links).
<b>Boot VID</b>	Boot voltage ID. This is the VDD and VDDNB voltage level that the processor requests from the external voltage regulator during the initial phase of the cold boot sequence. See <a href="#">2.5.1.2 [Internal VID Registers and Encodings]</a> .
<b>BCD</b>	Binary coded decimal number format.
<b>BSC</b>	Boot strap core. Core 0 of the <a href="#">BSP</a> . Specified by <a href="#">MSR0000_001B[BSC]</a> .
<b>BSP</b>	Boot strap processor. See <a href="#">2.3 [Processor Initialization]</a> .
<b>CAR</b>	Use of the L2 cache as RAM during boot. See <a href="#">2.3.3 [Using L2 Cache as General Storage During Boot]</a> .
<b>C-states</b>	These are ACPI-defined core power states. C0 is operational. All other C-states are low-power states in which the processor is not executing code. See <a href="#">2.5.3.2 [Core C-states]</a> .
<b>Canonical address</b>	An address in which the state of the most-significant implemented bit is duplicated in all the remaining higher-order bits, up to bit 63.
<b>Channel</b>	See DRAM channel.
<b>Channel interleaved mode</b>	Mode in which DRAM address space is interleaved between DRAM channels. See <a href="#">2.9.11 [Memory Interleaving Modes]</a> .
<b>CMP</b>	Chip multi-processing. Refers to processors that include multiple cores. See <a href="#">2.1 [Processor Overview]</a> .
<b>COF</b>	Current operating frequency of a given clock domain. See <a href="#">2.5.3 [CPU Power Management]</a> .
<b>Cold reset</b>	PWROK is deasserted and RESET_L is asserted. See <a href="#">2.3 [Processor Initialization]</a> .
<b>Compute Unit</b>	Two <a href="#">Cores</a> that share IC, DE, FP and L2 resources. See <a href="#">2.1 [Processor Overview]</a> .
<b>Core</b>	The instruction execution unit of the processor. See <a href="#">2.1 [Processor Overview]</a> .
<b>CPB</b>	Core performance boost. See <a href="#">2.5.9.1 [Core Performance Boost (CPB)]</a> .
<b>CpuCore-Num</b>	Specifies the core number. See <a href="#">2.4.4 [Processor Cores and Downcoring]</a> .
<b>CPUID function X</b>	Refers to the CPUID instruction when EAX is preloaded with X. See <a href="#">3.18 [CPUID Instruction Registers]</a> .
<b>CS</b>	Chip select. See <a href="#">D18F2x[5C:40]_dct[3:0] [DRAM CS Base Address]</a> .
<b>DCT</b>	DRAM controller. See <a href="#">2.9 [DRAM Controllers (DCTs)]</a> .
<b>DCQ</b>	DRAM controller queue.
<b>DDR3</b>	DDR3 memory technology. See <a href="#">2.9 [DRAM Controllers (DCTs)]</a> .
<b>DID</b>	Divisor identifier. Specifies the post-PLL divisor used to reduce the COF. See <a href="#">2.5.3 [CPU Power Management]</a> .
<b>Doubleword</b>	A 32-bit value.
<b>Downcoring</b>	Removal of cores. See <a href="#">2.4.4 [Processor Cores and Downcoring]</a> .

Table 4: Definitions

Term	Definition
<b>DRAM channel</b>	The part of the DRAM interface that connects to a DIMM. See <a href="#">2.9 [DRAM Controllers (DCTs)]</a> .
<b>Dual-Plane</b>	Refers to a processor or systemboard where VDD and VDDNB are separate and may operate at independent voltage levels. Refer to <a href="#">2.5.1 [Processor Power Planes And Voltage Control]</a> .
<b>DW</b>	Doubleword. A 32-bit value.
<b>ECS</b>	Extended configuration space. See <a href="#">2.7 [Configuration Space]</a> .
<b>EDS</b>	Electrical data sheet. See <a href="#">1.2 [Reference Documents]</a> .
<b>FCH</b>	Fusion Controller Hub. The platform device that contains the bridge to the system BIOS.
<b>FDS</b>	Functional data sheet; there is one FDS for each package type.
<b>FID</b>	Frequency identifier. Specifies the PLL frequency multiplier for a given clock domain. See <a href="#">2.5.3 [CPU Power Management]</a> .
<b>FreeR-unSample-Timer</b>	An internal free running timer used by many power management features. The timer increments at the rate specified by <a href="#">D18F4x110[CSampleTimer]</a> .
<b>GB</b>	Gbyte or Gigabyte; 1,073,741,824 bytes.
<b>#GP</b>	A general-protection exception.
<b>#GP(0)</b>	Notation indicating a general-protection exception (#GP) with error code of 0.
<b>GpuEnabled</b>	GpuEnabled = ( <a href="#">D1F0x00!</a> =FFFF_FFFFh).
<b>GT/s</b>	Giga-transfers per second.
<b>HCD</b>	Host Controller Driver. A software component.
<b>HTC</b>	Hardware thermal control. See <a href="#">2.10.3.1 [PROCHOT_L and Hardware Thermal Control (HTC)]</a> .
<b>HTC-active state</b>	Hardware-controlled lower-power, lower-performance state used to reduce temperature. See <a href="#">2.10.3.1 [PROCHOT_L and Hardware Thermal Control (HTC)]</a> .
<b>IBS</b>	Instruction based sampling. See <a href="#">2.6.2 [Instruction Based Sampling (IBS)]</a> .
<b>IFCM</b>	Isochronous flow-control mode, as defined in the link specification.
<b>ILM</b>	Internal loopback mode. Mode in which the link receive lanes are connected directly to the transmit lanes of the same link for testing and characterization. See <a href="#">D18F0x[18C:170] [Link Extended Control]</a> .
<b>IO configuration</b>	Access to configuration space through IO ports CF8h and CFCh. See <a href="#">2.7 [Configuration Space]</a> .
<b>IORR</b>	IO range register. See <a href="#">MSRC001_00[18,16] [IO Range Base (IORR_BASE[1:0])]</a> .
<b>IOMMU</b>	I/O Memory Management Unit. Also known as AMD Virtualization™ Technology.
<b>KB</b>	Kbyte or Kilobyte; 1024 bytes.
<b>L1 cache</b>	The level 1 caches (instruction cache and the data cache) and the level 2 caches. See <a href="#">2.1 [Processor Overview]</a> .
<b>L2 cache</b>	
<b>Linear (virtual) address</b>	The address generated by a core after the segment is applied.
<b>Link</b>	Generic term that refers to a refer to PCIe® link.
<b>LINT</b>	Local interrupt.

Table 4: Definitions

Term	Definition
<b>Logical address</b>	The address generated by a core before the segment is applied.
<b>LVT</b>	Local vector table. A collection of APIC registers that define interrupts for local events. E.g., <a href="#">APIC[530:500] [Extended Interrupt [3:0] Local Vector Table]</a> .
<b>Master abort</b>	This is a PCI-defined term that is applied to transactions on other than PCI buses. It indicates that the transaction is terminated without affecting the intended target; reads return all 1's; writes are discarded; the master abort error code is returned in the response, if applicable; master abort error bits are set if applicable.
<b>MB</b>	Megabyte; 1024 KB.
<b>MCT</b>	Memory controller. See <a href="#">2.8 [Northbridge (NB)]</a> .
<b>MCQ</b>	Memory controller queue. See <a href="#">2.8 [Northbridge (NB)]</a> .
<b>Micro-op</b>	Micro-op. Instructions have variable-length encoding and many perform multiple primitive operations. The processor does not execute these complex instructions directly, but, instead, decodes them internally into simpler fixed-length instructions called macro-ops. Processor schedulers subsequently break down macro-ops into sequences of even simpler instructions called micro-ops, each of which specifies a single primitive operation. See <i>Software Optimization Guide for AMD Family 15h Processors</i> .
<b>MEMCLK</b>	Refers to the clock signals, M[B, A][3:0]_CLK, that are driven from the processor to DDR DIMMs.
<b>MMIO</b>	Memory-mapped input-output range. This is physical address space that is mapped to the IO functions such as the IO links or MMIO configuration. The IO link MMIO ranges are specified by <a href="#">D18F1x[2CC:2A0,1CC:180,BC:80] [MMIO Base/Limit]</a> .
<b>MMIO configuration</b>	Access to configuration space through memory space. See <a href="#">2.7 [Configuration Space]</a> .
<b>MSR</b>	Model-specific register. The core includes several MSRs for general configuration and control. See <a href="#">3.19 [MSRs - MSR0000_xxxx]</a> for the beginning of the MSR register definitions.
<b>MTRR</b>	Memory-type range register. The MTRRs specify the type of memory associated with various memory ranges. See <a href="#">MSR0000_00FE</a> , <a href="#">MSR0000_020[F:0]</a> , <a href="#">MSR0000_02[6F:68,59:58,50]</a> , and <a href="#">MSR0000_02FF</a> .
<b>NB</b>	Northbridge. The transaction routing block of the node. See <a href="#">2.1 [Processor Overview]</a> .
<b>NBC</b>	NBC = ( <a href="#">CPUID Fn0000_0001_EBX[LocalApicId[3:0]]==0</a> ). Node Base Core. The lowest numbered core in the node.
<b>NBPMC</b>	Performance monitor counter. See <a href="#">2.6.1.2 [NB Performance Monitor Counters]</a> .
<b>NCLK</b>	The main northbridge clock. The NCLK frequency is the NB COF.
<b>Node</b>	See <a href="#">2.1 [Processor Overview]</a> .
<b>Normalized address</b>	Addresses used by DCTs. See <a href="#">2.8 [Northbridge (NB)]</a> .
<b>OW</b>	Octword. An 128-bit value.
<b>ODM</b>	On-DIMM mirroring. See <a href="#">D18F2x[5C:40]_dct[3:0][OnDimmMirror]</a> .
<b>ODT</b>	On-die termination, which is applied DRAM interface signals.
<b>ODTS</b>	DRAM On-die thermal sensor.
<b>Operational frequency</b>	The frequency at which the processor operates. See <a href="#">2.5 [Power Management]</a> .

**Table 4: Definitions**

Term	Definition
<b>PCIe®</b>	PCI Express®.
<b>PDS</b>	Product data sheet.
<b>Physical address</b>	Addresses used by cores in transactions sent to the NB.
<b>PMC</b>	Performance monitor counter. See <a href="#">2.6.1.1 [Core Performance Monitor Counters]</a> .
<b>PRBS</b>	Pseudo-random bit sequence.
<b>Processor</b>	See <a href="#">2.1 [Processor Overview]</a> .
<b>PSI</b>	Power Status Indicator. See <a href="#">2.5.1.3.1 [PSIx_L Bit]</a> .
<b>P-state</b>	Performance state. See <a href="#">2.5 [Power Management]</a> .
<b>PTE</b>	Page table entry.
<b>QW</b>	Quadword. A 64-bit value.
<b>RAS</b>	Reliability, availability and serviceability (industry term). See <a href="#">2.15.1 [Machine Check Architecture]</a> .
<b>RDQ</b>	Read data queue.
<b>REFCLK</b>	Reference Clock, refers to the clock frequency (100 MHz) or the clock period (10 ns) depending on the context used.
<b>RX</b>	Receiver.
<b>Scrubber</b>	Background memory checking logic. See <a href="#">2.8.3 [Memory Scrubbers]</a> .
<b>Shutdown</b>	A state in which the affected core waits for either INIT, RESET, or NMI. When shutdown state is entered, a shutdown special cycle is sent on the IO links.
<b>Single-Plane</b>	Refers to a processor or systemboard where VDD and VDDNB are tied together and operate at the same voltage level. Refer to <a href="#">2.5.1 [Processor Power Planes And Voltage Control]</a> .
<b>Slam</b>	Refers to changing the voltage to a new value in one step (as opposed to stepping). See <a href="#">2.5.1.4.1 [Hardware-Initiated Voltage Transitions]</a> .
<b>SMAF</b>	System management action field. This is the code passed from the SMC to the processors in STPCLK assertion messages. The action taken by the processors in response to this message is specified by <a href="#">D18F3x[84:80] [ACPI Power State Control]</a> .
<b>SMBus</b>	System management bus. Refers to the protocol on which the serial VID interface (SVI) commands are based. See <a href="#">2.5.1 [Processor Power Planes And Voltage Control]</a> , and <a href="#">1.2 [Reference Documents]</a> .
<b>SMC</b>	System management controller. This is the platform device that communicates system management state information to the processor through an IO link, typically the system IO hub.
<b>SMI</b>	System management interrupt. See <a href="#">2.4.9.2.1 [SMM Overview]</a> .
<b>SMM</b>	System management mode. See <a href="#">2.4.9.2 [System Management Mode (SMM)]</a> .
<b>Speculative event</b>	A performance monitor event counter that counts all occurrences of the event even if the event occurs during speculative code execution.
<b>SVI2</b>	Serial VID 2.0 interface. See <a href="#">2.5.1.1 [Serial VID Interface]</a> .
<b>SVM</b>	Secure virtual machine. See <a href="#">2.4.10 [Secure Virtual Machine Mode (SVM)]</a> .
<b>Sync flood</b>	The propagation of continuous sync packets to all links. This is used to quickly stop the transmission of potentially bad data when there are no other means to do so. See the link specification for additional information.



**Table 4: Definitions**

Term	Definition
<b>TCC</b>	Temperature calculation circuit. See <a href="#">2.10 [Thermal Functions]</a> .
<b>Tctl</b>	Processor temperature control value. See <a href="#">2.10.3 [Temperature-Driven Logic]</a> .
<b>TDC</b>	Thermal design current. See the AMD Infrastructure Roadmap, #41482.
<b>TDP</b>	Thermal design power. A power consumption parameter that is used in conjunction with thermal specifications to design appropriate cooling solutions for the processor. See <a href="#">2.5.9.2 [TDP Limiting]</a> .
<b>Token</b>	A scheduler entry used in various northbridge queues to track outstanding requests. See <a href="#">D18F3x140 [SRI to XCS Token Count]</a> on Page 461.
<b>TX</b>	Transmitter.
<b>UI</b>	Unit interval. This is the amount of time equal to one half of a clock cycle.
<b>UMI</b>	Unified Media Interface. The link between the processor and the FCH.
<b>VDD</b>	Main power supply to the processor core logic.
<b>VDDNB</b>	Main power supply to the processor NB logic.
<b>VID</b>	Voltage level identifier. See <a href="#">2.5.1 [Processor Power Planes And Voltage Control]</a> .
<b>Virtual CAS</b>	The clock in which CAS is asserted for the burst, N, plus the burst length (in MEMCLKs), minus 1; so the last clock of virtual CAS = $N + (BL/2) - 1$ .
<b>VRM</b>	Voltage regulator module.
<b>W</b>	Word. A 16-bit value.
<b>Warm reset</b>	RESET_L is asserted only (while PWROK stays high). See <a href="#">2.3 [Processor Initialization]</a> .
<b>WDT</b>	Watchdog timer. A timer that detects activity and triggers an error if a specified period of time expires without the activity. For example, see <a href="#">MSRC001_0074 [CPU Watchdog Timer (Cpu-WdtCfg)]</a> or the NB watchdog timer in <a href="#">D18F3x40 [MCA NB Control]</a> .
<b>WDQ</b>	Write data queue.
<b>XBAR</b>	Cross bar; command packet switch. See <a href="#">2.8 [Northbridge (NB)]</a> .

## 1.5 Changes Between Revisions and Product Variations

### 1.5.1 Revision Conventions

The processor revision is specified by [CPUID Fn0000\\_0001\\_EAX \[Family, Model, Stepping Identifiers\]](#) or [CPUID Fn8000\\_0001\\_EAX \[Family, Model, Stepping Identifiers\]](#). This document uses a revision letter instead of specific model numbers. The following table contains the definitions based on model and stepping used in this document. Where applicable, the processor stepping is indicated after the revision letter. All behavior marked with a revision letter apply to future revisions unless they are superseded by a change in a later revision. See the revision guide for additional information about revision determination. See [1.2 \[Reference Documents\]](#).

**Table 5: Processor revision conventions**

Term	Definition
<b>PROC</b>	Processor. PROC = {CPUID Fn0000_0001_EAX[ExtFamily], {CPUID Fn0000_0001_EAX[ExtModel], CPUID Fn0000_0001_EAX[BaseModel]}, CPUID Fn0000_0001_EAX[Stepping]}.
<b>KV_A1</b>	KV_A1 = {06h,30h,1h}.

### 1.5.2 Major Changes

This section describes the major changes relative to Family 15h Models 10h-1Fh Processors.

- CPU core changes:
  - Architectural changes:
    - XSAVEOPT: Added XSAVE optimization. Reported by CPUID Fn0000\_000D\_EAX\_x1[XSAVE-OPT].
    - PTSC: Added “Performance Time Stamp Counter” that is a synchronized value across all cores and the GPU. Used by LWP. See MSRC001\_0280. Reported by CPUID Fn8000\_0001\_ECX[PerfTsc] and CPUID Fn8000\_0008\_ECX[PerfTscSize].
    - DataBreakpointExtension: Added debug breakpoint address matching enhancement. See CPUID Fn8000\_0001\_ECX[DataBreakpointExtension], MSRC001\_1027[31:12], and MSRC001\_101[B:9].
    - LWP: Added LWP support for Global Timestamp Counter and Continuous Wrapping Mode. See CPUID Fn8000\_001C\_EAX[LwpPTSC, LwpCont], MSRC000\_0105[LwpPTSC, LwpCont], CPUID Fn8000\_001C\_EDX[LwpPTSC, LwpCont].
    - PCID: Added software ASID support. Reported by CPUID Fn0000\_0001\_ECX[PCID].
    - FSGSBASE: Add ability for user code to write FS and GS segments. This facilitates user mode scheduling of threads. Reported by CPUID Fn0000\_0007\_EBX\_x0[FSGSBASE].
  - IPC changes:
    - Store to load forwarding optimization.
    - Dispatch and retire up to 2 stores per cycle.
    - Improved memfile, from last 3 stores to last 8 stores, and allow tracking of dependent stack operations.
    - Load queue (LDQ) size increased to 48, from 44.
    - Store queue (STQ) size increased to 32, from 24.
    - Increase dispatch bandwidth to 8 INT ops per cycle (4 to each core), from 4 INT ops per cycle (4 to just 1 core). 4 ops per cycle per core remains unchanged.
    - Accelerate SYSCALL/SYSRET.
    - Increased L2 BTB size from 5K to 10K and from 8 to 16 banks.
    - Added L2 BTB extended target array. Provides full physical address when relative address is insufficient.
    - Improved branch prediction.
    - Improved loop prediction.
    - Increase PFB from 8 to 16 entries; the 8 additional entries can be used either for prefetch or as a loop buffer.
    - Increase snoop tag throughput.
    - Change from 4 to 3 FP pipe stages.
  - MSR Changes:
- Cache changes:
  - IC: Increased from 64 KB (2-way) to 96 KB (3-way).
- TLB changes:
- Memory controller changes:

- Links and IO changes:
- RAS-related changes:
  - L2 single bit errors corrected in array; L2 single bit errors corrected previously only corrected/poisoned to requestor, leaving single bit error in array.
- Northbridge changes:
- Power management changes:
  - Dynamic L2 Power Gating. Reduce L2 leakage by reducing the number of L2 ways on C6 exit according to usage.
- Core/NB performance counter changes:
  - Increase Onion Bandwidth. Double to 32Byte width in each direction.
  - Add coherency for FSA. Add FSA 0.85 support.
    - Add second onion bus
    - Support for PCIe® and OpenCL™ atomics:
    - Config bit to enable command throttling on onion
  - Add support for GNB DSM
    - Incorporate StopClocks from GNB:
    - Incorporate Cross Triggers from GNB:
    - Incorporate SelfRefresh, HTReceiveDisable from GNB
  - Bandwidth Improvements
    - Local probe responses bypass SRQ -> MCT
    - Send SrcDone based on TgtDone
    - Two commands per clock from MCT/XBR -> SRQ
    - Two commands per clock from SRI -> MCQ; MCQ can sink two responses/clock
    - SRQ/SRA/SRD +16 (see SRQ Changes)
    - MCQ +16
    - LCS/LPS +16
    - Improve write holding register bandwidth
  - Supply DRAM utilization as a frequency sensitivity hint to the OS
  - Memory parking performance counters. Over time shift traffic from all channels to one channel.
  - Add onion bus.
  - Add PCIe® endpoint mode.
  - 2 or 3 core-pairs Add 3 CU support.
  - Buffer size changes
  - SMU Pstate Control

### 1.5.2.1 Major Changes to Core/NB Performance Counters

Major Changes to Core/NB Performance Counters:

- Core performance counters:
  - [PMCx000\[7,3\]](#): Changed to reserved; Removed pipe 3.
  - [PMCx042 \[Data Cache Refills from L2 or System\]](#): Added [4].
  - [PMCx060](#), [PMCx061\[5:0\]](#), [PMCx062](#), [PMCx063](#), [PMCx064](#): Added.
  - [PMCx186 \[Uops Dispatched From Decoder\]](#): Added.
  - [PMCx0D1](#), [PMCx0D5-PMCx0D8](#), [PMCx1D8](#), [PMCx1DD-PMCx1DE](#): These events count even when dispatch selects the other core of the compute-unit.
  - [PMCx1D0 \[Retired Fused Branch Instructions\]](#): Added.
  - [PMCx1DF \[FP Dispatch Contention\]](#): Changed.

## 2 Functional Description

### 2.1 Processor Overview

The *processor* is defined as follows:

- The processor is a package that contains one node.
- Supports x86-based instruction sets.
- Packages:
  - FM2r2: Desktop Package.
  - FP3: Notebook Package.
  - See [CPUID Fn8000\\_0001\\_EBX\[PkgType\]](#).
- Compute Unit
  - 2 cores per compute unit. Up to 2 compute units.
  - 2 MB L2
  - See [2.4.1 \[Compute Unit\]](#).
- DRAM:
  - Configurable to two 64-bit DDR3 memory channels (A, B). See [Figure 2 \[A processor\]](#).
  - ECC: Yes.
  - Max speed: 2133 MT/s (1.5V).
  - See [2.9.2](#) for voltage control affecting DRAM speed.
- Northbridge:
  - One communication packet routing block referred to as the northbridge (NB). The NB routes transactions between the cores, the link, and the DRAM interfaces. It includes the configuration register space for the device.
- Graphics northbridge:
  - Links:
    - PCIe® Gen3 on Gfx link, PCIe® Gen2 on the GPP links and PCIe® Gen2 on the UMI link.
    - Gfx lanes: One x16, GPP lanes: One x4, UMI lanes: One x4.
    - See [2.11.3 \[Links\]](#).
    - See [2.11.3.1](#) for voltage control affecting data rate of the Gfx link .
- Power Management:
  - See [2.5 \[Power Management\]](#).
- RAS:
  - See [2.15 \[RAS Features\]](#).

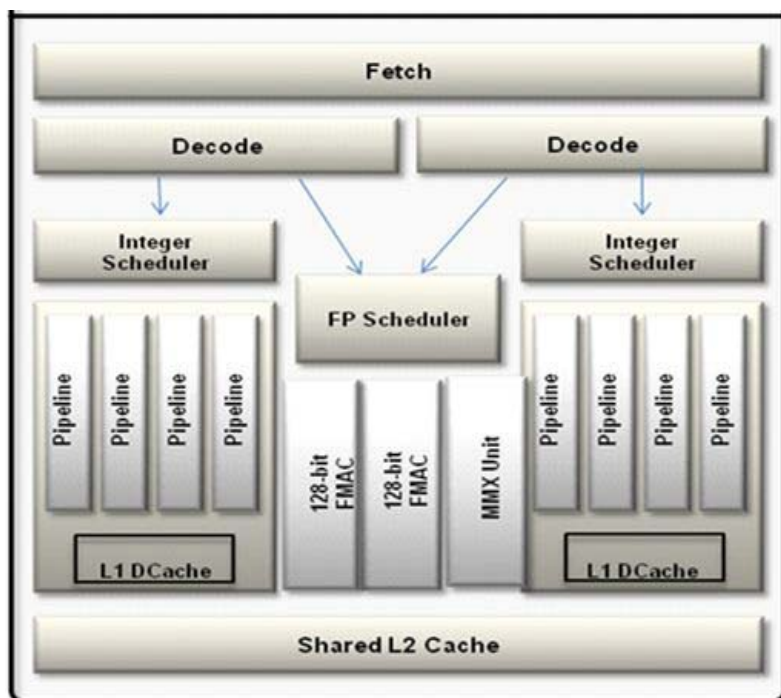


Figure 1: A Compute Unit

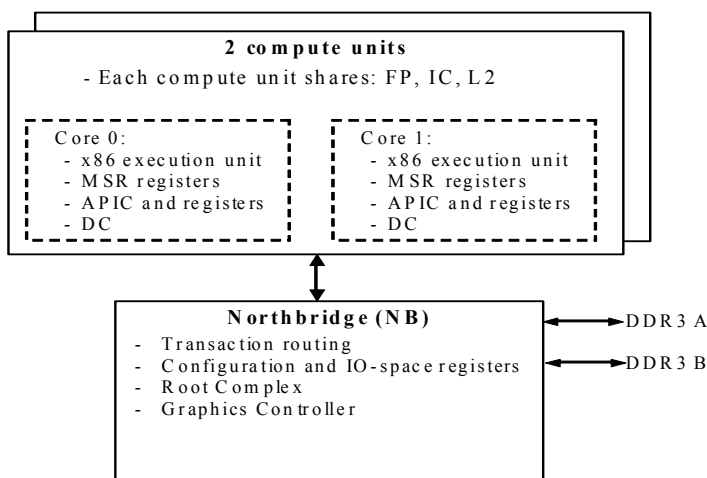


Figure 2: A processor

## 2.2 System Overview

## 2.3 Processor Initialization

This section describes the initialization sequence after a cold reset.

Core 0 of the processor, the bootstrap core (BSC), begins executing code from the reset vector. The remaining cores do not fetch code until their enable bits are set ([D18F0x1DC\[CpuEn\]](#)).

### 2.3.1 BSC Initialization

The BSC must perform the following tasks as part of boot.

- Store BIST information from the EAX register into an unused processor register.
- [D18F0x6C](#)[InitDet] may be used by BIOS to differentiate between INIT and cold/warm reset.
- Determine type of startup using [D18F0x6C](#)[ColdRstDet].
  - If this is a warm reset then BIOS may check for valid MCA errors and if present save the status for later use. See [2.15.1.6 \[Handling Machine Check Exceptions\]](#).
- Enable the cache, program the MTRRs for [CAR](#) and initialize [CAR](#). See [2.3.3 \[Using L2 Cache as General Storage During Boot\]](#).
- Setup the SMU.
- Setup of APIC ([2.4.9.1.3 \[ApicId Enumeration Requirements\]](#)).
- Setup the link configuration [2.11.3.2 \[Link Configurations\]](#).
- Setup the root complex and initialize the I/O links [2.11.4.3 \[Link Configuration and Initialization\]](#).
- If required, reallocate data and flow control buffers of the links (see [D18F0x\[F0,D0,B0,90\]](#) [[Link Base Channel Buffer Count](#)] and [D18F0x\[F4,D4,B4,94\]](#) [[Link Isochronous Channel Buffer Count](#)]).
- Issue system warm reset.
- Configure the DRAM controllers.
- Configure processor power management. See [2.5 \[Power Management\]](#).
- Allow other cores to begin fetching instructions by setting [D18F0x1DC](#)[CpuEn] in the PCI configuration space of all nodes. See [2.4.4 \[Processor Cores and Downcoring\]](#).

### 2.3.2 AP Initialization

All other processor cores other than core 0 begin executing code from the reset vector. They must perform the following tasks as part of boot.

- Store BIST information from the eax register into an unused processor register.
- [D18F0x6C](#)[InitDet] may be used by BIOS to differentiate between INIT and cold/warm reset.
- Determine the history of this reset using the [D18F0x6C](#) [[Link Initialization Control](#)] [[ColdRstDet](#)] bit:
  - If this is a warm reset then BIOS may check for valid MCA errors and if present save the status for use later. See [2.15.1.6 \[Handling Machine Check Exceptions\]](#).
- Set up the local APIC. See [2.4.9.1.3 \[ApicId Enumeration Requirements\]](#).
- Configure processor power management. See [2.4 \[Core\]](#).

### 2.3.3 Using L2 Cache as General Storage During Boot

Prior to initializing the DRAM controller for system memory, BIOS may use the L2 cache of each core as general storage.

The L2 cache as general storage is described as follows:

- Each Compute Unit has its own L2 cache.
- BIOS manages the mapping of the L2 storage such that cacheable accesses do not cause L2 victims.
- The L2 size, L2 associativity, and L2 line size is determined by reading [CPUID Fn8000\\_0006\\_ECX](#)[L2Size, L2Assoc, L2LineSize]. L2WayNum is defined to be the number of ways indicated by the L2Assoc code.
  - The L2 cache is viewed as (L2Size/L2LineSize) cache lines of storage, organized as L2WayNum ways, each way being (L2Size/L2WayNum) in size.
    - E.g. L2Assoc=8 so L2WayNum=16 (there are 16 ways). If (L2Size=2MB) then there are 16 blocks of cache, each 2MB/16 in size, or 128KB each.
  - For each of the following values of L2Size, the following values are defined:

- L2Size=1 MB: L2Tag=PhysAddr[39:16], L2WayIndex=PhysAddr[15:6].
- L2Size=2 MB: L2Tag=PhysAddr[39:17], L2WayIndex=PhysAddr[16:6].
- PhysAddr[5:0] addresses the L2LineSize number of bytes of storage associated with the cache line.
- The L2 cache, when allocating a line at L2WayIndex:
  - Picks an invalid way before picking a valid way.
  - Prioritizes the picking of invalid ways such that way L2WayNum-1 is the highest priority and 0 is the lowest priority.
- It is recommended that BIOS assume a simpler allocation of L2 cache memory, being L2WayNum size-aligned blocks of memory, each being L2Size/L2WayNum bytes.
- BIOS can rely on a minimum L2Size of 256 KB and can rely on being able to use a minimum of 14 ways for general storage. See [CPUID Fn8000\\_0006\\_ECX\[L2Size\]](#). See initialization requirements below for [MSRC001\\_1023\[L2WayLock, L2FirstLockedWay\]](#).

The following memory types are supported:

- WP-IO: BIOS ROM may be assigned the write-protect IO memory type and may be accessed read-only as data and fetched as instructions.
  - WP-IO accesses, both read and write, do not get evicted to the L2 and therefore do not need to be considered for allocation into the L2.
- WB-DRAM: General storage may be assigned the write-back DRAM memory type and may be accessed as read-write data, but not accessed by instruction fetch.
  - BIOS initializes an L2LineSize sized and aligned location in the L2 cache, mapped as write-back DRAM, with 1 read to at least 1 byte of the L2LineSize sized and aligned WB-DRAM address. BIOS may store to a line only after it has been allocated by a load.
  - Fills, sent to the disabled memory controller, return undefined data.
- All of memory space that is not accessed as WP-IO or WB-DRAM space must be marked as UC memory type.
- In order to prevent victimizing L2 data, no more than L2WayNum cache lines accessed as WB-DRAM may have the same L2WayIndex.
  - Software does not need to know which ways the L2WayNum lines are allocated to for any given value of L2WayIndex, only that invalid ways will be selected for allocation before valid ways will be selected for allocation.
  - Software is not allowed to deallocate a line in the L2 by using CLFLUSH.

Performance monitor event [PMCx07F\[1\]](#), titled “L2 Writebacks to system“, can be used to indicate whether L2 dirty data was lost by being victimized and sent to the disabled memory controller.

The following requirements must be satisfied prior to using the cache as general storage:

- Paging must be disabled.
- [MSRC001\\_0015\[INVDWBINVD\]](#)=0.
- [MSRC001\\_1020\[DisSS\]](#)=1.
- [MSRC001\\_1021\[DisSpecTlbRld\]](#)=1. Disable speculative ITLB reloads.
- [MSRC001\\_1022\[DisSpecTlbRld\]](#)=1. Disable speculative DTLB reloads.
- [MSRC001\\_1022\[DisHwPf\]](#)=1.
- [MSRC001\\_102B\[CombineCr0Cd\]](#)=0. See [MSRC001\\_102B\[CombineCr0Cd\]](#).
- CLFLUSH, INVD, and WBINVD must not be used during [CAR](#) but may be used when tearing down [CAR](#) for all compute units on a node.
- The BIOS must not use SSE, or MMX™ instructions, with the exception of the following list: MOVD, MOVQ, MOVDQA, MOVQ2DQ, MOVDQ2Q.
- The BIOS must not enable exceptions, page-faults, and other interrupts.
- BIOS must not use software prefetches.



- UC-DRAM: All of DRAM that is not accessed as WB-DRAM space must be marked as UC memory type.
- If (`MSRC001_1023[L2WayLock]==1`) then:
  - Only the ways 0 through (`MSRC001_1023[L2FirstLockedWay]-1`) may be used for general storage.
  - BIOS can rely on `MSRC001_1023[L2FirstLockedWay]` to have a minimum value of Eh.
- If (`MSRC001_1023[L2WayLock]==0`) then:
  - Set `MSRC001_1023[L2WayLock]=1`.
  - Set `MSRC001_1023[L2FirstLockedWay]=Fh`.

When BIOS has completed using the cache for general storage the following steps are followed:

1. An INVD instruction is executed on each core that used cache as general storage; an INVD is issued when all cores on all nodes have completed using the cache for general storage.
2. If DRAM is initialized and there is data in the cache that needs to get moved to main memory, CLFLUSH or WBINVD may be used instead of INVD, but software must ensure that needed data in main memory is not overwritten.
3. Program the following configuration state (Order is unimportant):
  - `MSRC001_0015[INVDWBINVD]=1`.
  - `MSRC001_1020[DisSS]=0`.
  - `MSRC001_1021[DisSpecTlbRld]=0`.
  - `MSRC001_1022[DisSpecTlbRld]=0`.
  - `MSRC001_1022[DisHwPf]=0`.
  - If (`((MSRC001_1023[L2WayLock]==1) & (MSRC001_1023[L2FirstLockedWay]==Fh))`), program `MSRC001_1023[L2WayLock]=0`.

## 2.4 Core

The majority of the behavioral definition of the core is specified in the AMD64 Architecture Programmer's Manual. See [1.2 \[Reference Documents\]](#).

### 2.4.1 Compute Unit

Each *compute unit* includes 2 cores each having an x86 instruction execution logic and first-level (L1) data cache. The FP unit, second level (L2) general-purpose cache, and first-level instruction cache, are shared between both cores of the compute unit.

There is a set of MSRs and APIC registers associated with each core. Processors that include multiple cores are said to incorporate *chip multi-processing* or CMP. Unless otherwise specified the processor configuration interface hides the Compute Unit implementation and presents software with homogenous cores, each independent of the other.

Software may use `D18F5x80[Enabled, DualCore]` in order to associate a core with a Compute Unit. This information can be useful because some configuration settings are determined based on active Compute Units and core performance may vary based on resource sharing within a Compute Unit.

**Table 6: Compute Unit Definitions**

Term	Definition
<b>NumOfCompUnits</b>	The number of compute units for which at least 1 core is enabled. <code>NumOfCompUnits = COUNT(D18F5x80[Enabled])</code> .
<b>DualCoreEnabled</b>	Both cores of a compute unit are enabled. <code>DualCoreEnabled = (D18F5x80[DualCore[0]]==1)</code> . 0=Core 0 enabled, Core 1 disabled.



## 2.4.2 Caches and TLBs

Cache and TLB storage available to a core is reported by:

- [CPUID Fn8000\\_0005\\_EAX](#)-[CPUID Fn8000\\_0006\\_EDX](#).
- [CPUID Fn8000\\_0019\\_EAX](#)-[CPUID Fn8000\\_0019\\_E\[D,C\]X](#).
- [CPUID Fn8000\\_001D\\_EAX\\_x0](#)-[CPUID Fn8000\\_001E\\_EDX](#).

Cache and TLB storage available to a core is summarized as follows:

- L1 and L2 Caches:
  - DC: 16 KB, 4-way, write-through, per-core.
  - IC: 96 KB, 2-way, shared between cores of a compute unit.
  - L2: 1 MB or 2MB (Product-specific), 16-way associative, shared between both cores of a compute unit.
- TLBs:
  - D, L1TLB:
    - 4 KB: 32 entries, fully associative.
    - 2 MB: 32 entries, fully associative.
    - 1 GB: 32 entries, fully associative.
  - D, L2TLB:
    - None. Full size of unified TLB reported as L2 DTLB.
  - I, L1TLB:
    - 4 KB: 48 entries, fully associative.
    - 2 MB, 1 GB: 24 entries, fully associative. 2M and 1G entries share the same L1TLB bank.
  - I, L2TLB:
    - 4 KB: 512 entries, 4-way associative. (Same as Fam10h)
    - 2 MB: None. Full size of unified TLB reported as L2 ITLB.
    - 1 GB: None. Full size of unified TLB reported as L2 ITLB.
  - Unified TLB:
    - 1024 entries, 8-way associative, any entry can cache:
      - D: 4K, 2M, 4M, or 1G translation.
      - I: 2M, 4M, or 1G translation. Not 4K ITLB translations.
      - Notes: Unified TLB natively stores 4M translations. An entry allocated by one core is not visible to the other core of a compute unit.

### 2.4.2.1 Registers Shared by Cores in a Compute Unit

Some registers are implemented one instance per Compute Unit instead of per core; these registers are designated as [Per-compute-unit](#). The absence of [Per-compute-unit](#) implies the normal per-core instance programming model.

Some [Per-compute-unit](#) MSRs are implemented as registers that when read the contents are saved in the L1 data cache and are not coherent between cores; these registers are called [SharedNC](#) or “shared non-coherent”.

Programming rules for [Per-compute-unit](#) registers:

- Software must ensure that a shared MSR written by one core on a Compute Unit will not cause a problem for software that is running on the other core of the Compute Unit.
- Not [SharedNC](#): A write to a MSR does not have to be written to the other core of the compute unit in order for the other core to see the updated value.
- [SharedNC](#): A write to a [SharedNC](#) MSR has to be written to both cores of the compute unit in order for both cores to see the updated value.
  - If software can know that the other core has not read the [SharedNC](#) MSR since the last warm reset, then a write is not needed to the [SharedNC](#) MSR on the other core.
  - Software may not rely on the other core maintaining the previous value of the [SharedNC](#) MSR.

- The [SharedNC](#) MSRs are: [MSRC001\\_00\[35:30\]](#), [MSRC001\\_0054](#).
- A read-modify-write of a shared MSR register is not atomic. Software must ensure atomicity between the cores that could simultaneously read-modify-write the shared register.

### 2.4.3 Virtual Address Space

The processor supports 48 address bits of virtual memory space (256 TB) as indicated by [CPUID Fn8000\\_0008\\_EAX](#).

### 2.4.4 Processor Cores and Downcoring

Each node supports downcoring as follows:

- The number of cores supported is specified by [D18F5x84\[CmpCap\]](#).
- The cores of a compute unit may be software downcored by [D18F3x190\[DisCore\]](#) if ([DualCoreEnabled](#)==1). If ([DualCoreEnabled](#)==0) then the cores of a compute unit may not be software downcored. See [2.4.4.1 \[Software Downcoring using D18F3x190\[DisCore\]\]](#).
  - All cores of a compute unit must be downcored if either core needs to be downcored.
  - Clocks are turned off and power is gated to downcored Compute Units. The power savings is the same as CC6.
  - There must be at least 1 Compute Unit enabled.
  - [D18F3x190\[DisCore\]](#) affects the value of [CPUID Fn0000\\_0001\\_EBX\[LogicalProcessorCount\]](#), [CPUID Fn0000\\_0001\\_EDX\[HTT\]](#), [CPUID Fn8000\\_0001\\_ECX\[CmpLegacy\]](#), [CPUID Fn8000\\_0008\\_ECX\[NC\]](#), [D18F5x80\[Enabled, DualCore\]](#). [D18F3x190\[DisCore\]](#) does not affect the value of [D18F5x84\[CmpCap\]](#).
- An implemented (physical) core that is downcored is not visible to software. Cores that are not downcored are numbered logically in a contiguous manner.
- [D18F5x80 \[Compute Unit Status 1\]](#) reports core topology information to software.
- The number of cores specified in [CPUID Fn8000\\_0008\\_ECX\[NC\]](#) must be the same as the number of cores enabled in [D18F0x1DC\[CpuEn\]](#).
- The core number, *CpuCoreNum*, is provided to SW running on each core through [CPUID Fn0000\\_0001\\_EBX\[LocalApicId\]](#) and [APIC20\[ApicId\]](#); *CpuCoreNum* also affects [D18F0x1DC\[CpuEn\]](#). *CpuCoreNum*, varies as the lowest integers from 0 to [D18F5x84\[CmpCap\]](#), based on the number of enabled cores; e.g., a 4-core node with 1 core disabled results in cores reporting *CpuCoreNum* values of 0, 1, and 2 regardless of which core is disabled. The boot core is always the core reporting *CpuCoreNum*=0.

Some legacy operating systems do not support processors with a non-power-of-2 number of cores. The BIOS is recommended to support a user configurable option to disable cores down to a power-of-2 number of cores for legacy operating system support.

#### 2.4.4.1 Software Downcoring using D18F3x190[DisCore]

Cores may be downcored by [D18F3x190\[DisCore\]](#).

Software is required to use [D18F3x190\[DisCore\]](#) as follows:

- Setting bits corresponding to cores that are not present results in undefined behavior.
- Once a core has been removed by [D18F3x190\[DisCore\]=1](#), it cannot be added back without a cold reset. E.g. Software may only set *DisCore* bits, never clear them.
- Software may remove cores only once. If software removes cores by setting [D18F3x190\[DisCore\]=1](#), then software is not allowed to disable additional cores after the next warm reset.
- The most significant bit N is (the number of cores)-1 at cold reset; the number of cores at cold reset is ([CPUID Fn8000\\_0008\\_ECX\[NC\]](#)+1).

- The most significant bit N and the core ID significance of DisCore is not affected by the value of DisCore followed by a warm-reset.
  - E.g. If core 2 is disabled by DisCore[3:0]=0100b followed by a warm reset, then the new core 2 is the old core 3. If the new core 2 needs to then be disabled then DisCore[3:0]=1100b followed by a warm reset.
- All bits greater than bit N are reserved.
- If D18F3x190[DisCore] is changed, then the following need to be updated:
  - D18F0x60[CpuCnt[4:0]].
  - D18F5x170[NbPstateThreshold]
  - MSRC001\_102A[ThrottleNbInterface]

### 2.4.5 Physical Address Space

The processor supports a 40 bit physical address space, even though the core indicates support for a 48 bit physical address space. See CPUID Fn8000\_0008\_EAX [Long Mode Address Size Identifiers].

The processor master aborts the following upper-address transactions (to address PhysAddr):

- Link or core requests with non-zero PhysAddr[63:40].

### 2.4.6 System Address Map

The processor defines a reserved memory address region starting at 0000\_00FD\_0000\_0000h and extending up to 0000\_0100\_0000\_0000h. System software must not map memory into this region. Downstream host accesses to the reserved address region results in a page fault. Upstream system device accesses to the reserved address region results in an undefined operation.

#### 2.4.6.1 Memory Access to the Physical Address Space

All memory accesses to the physical address space from a core are sent to its associated northbridge (NB). All memory accesses from a link are routed through the NB. An IO link access to physical address space indicates to the NB the cache attribute (Coherent or Non-coherent, based on bit[0] of the Sized Read and Write commands).

A core access to physical address space has two important attributes that must be determined before issuing the access to the NB: the memory type (e.g., WB, WC, UC; as described in the MTRRs) and the access destination (DRAM or MMIO).

This mechanism is managed by the BIOS and does not require any setup or changes by system software.

##### 2.4.6.1.1 Determining Memory Type

The memory type for a core access is determined by the highest priority of the following ranges that the access falls in: 1==Lowest priority.

1. The memory type as determined by architectural mechanisms.
  - See the APM2 chapter titled “Memory System”, sections “Memory-Type Range Registers” and “Page-Attribute Table Mechanism”.
  - See the APM2 chapter titled “Nested Paging”, section “Combining Memory Types, MTRRs”.
  - See MSR0000\_02FF [MTRR Default Memory Type (MTRRdefType)], MSR0000\_020[F:0] [Variable-Size MTRRs Base/Mask], MSR0000\_02[6F:68,59:58,50] [Fixed-Size MTRRs].
2. TSeg & ASeg SMM mechanism. (see MSRC001\_0112 and MSRC001\_0113)
3. CR0[CD]: If (CR0[CD]==1) then MemType=CD.
4. MMIO config space, APIC space.

- MMIO APIC space and MMIO config space must not overlap.
  - MemType=UC.
  - See 2.4.9.1.2 [APIC Register Space] and 2.7 [Configuration Space].
5. If (“In SMM Mode” && ~((MSRC001\_0113[AValid] && “The address falls within the ASeg region”) || (MSRC001\_0113[TValid] && “The address falls within the TSeg region”))) then MemType=CD.

#### 2.4.6.1.2 Determining The Access Destination for Core Accesses

The access destination, DRAM or MMIO, is based on the highest priority of the following ranges that the access falls in: 1==Lowest priority.

1. RdDram/WrDram as determined by MSRC001\_001A [Top Of Memory (TOP\_MEM)] and MSRC001\_001D [Top Of Memory 2 (TOM2)].
2. The IORRs. (see MSRC001\_00[18,16] and MSRC001\_00[19,17]).
3. The fixed MTRRs. (see MSR0000\_02[6F:68,59:58,50] [Fixed-Size MTRRs])
4. TSeg & ASeg SMM mechanism. (see MSRC001\_0112 and MSRC001\_0113)
5. MMIO config space, APIC space.
  - MMIO APIC space and MMIO config space must not overlap.
  - RdDram=IO, WrDram=IO.
  - See 2.4.9.1.2 [APIC Register Space] and 2.7 [Configuration Space].
6. NB address space routing. See 2.8.2.1.1 [DRAM and MMIO Memory Space].

#### 2.4.7 Timers

Each core includes the following timers. These timers do not vary in frequency regardless of the current P-state or C-state.

- MSR0000\_0010 [Time Stamp Counter (TSC)]; the TSC increments at the rate specified by the P0 P-state.
  - See 2.5.3.1.1.1 [Software P-state Numbering].
  - See MSRC001\_00[6B:64] [P-state [7:0]].
- The APIC timer (APIC380 and APIC390), which increments at the rate of 2xCLKIN; the APIC timer may increment in units of between 1 and 8.

#### 2.4.8 Implicit Conditions for TLB Invalidation

The following family specific conditions will cause all TLBs for both cores of the compute unit to be invalidated; except MSR0000\_0277 which will only clear the TLBs for the core that did the MSR write. The architectural conditions that cause TLB invalidation are documented by the APM2 section titled “Translation-Lookaside Buffer (TLB)”; see “Implicit Invalidations”.

- MSR0000\_020[F:0] [Variable-Size MTRRs Base/Mask]
- MSR0000\_02[6F:68,59:58,50] [Fixed-Size MTRRs]
- MSR0000\_0277 [Page Attribute Table (PAT)] (TLBs not cleared for the other core)
- MSR0000\_02FF [MTRR Default Memory Type (MTRRdefType)]
- MSRC001\_0010 [System Configuration (SYS\_CFG)] write.
- MSRC001\_00[18,16] [IO Range Base (IORR\_BASE[1:0])] write.
- MSRC001\_00[19,17] [IO Range Mask (IORR\_MASK[1:0])] write.
- MSRC001\_001A [Top Of Memory (TOP\_MEM)] write.
- MSRC001\_001D [Top Of Memory 2 (TOM2)] write.
- MSRC001\_1023 [Combined Unit Configuration (CU\_CFG)] write.
- MSRC001\_102A [Combined Unit Configuration 2 (CU\_CFG2)] write.
- MSRC001\_102B [Combined Unit Configuration 3 (CU\_CFG3)] write.

## 2.4.9 Interrupts

### 2.4.9.1 Local APIC

The local APIC contains logic to receive interrupts from a variety of sources and to send interrupts to other local APICs, as well as registers to control its behavior and report status. Interrupts can be received from:

- IO devices including the IO hub (IO APICs)
- Other local APICs (inter-processor interrupts)
- APIC timer
- Thermal events
- Performance counters
- Legacy local interrupts from the IO hub (INTR and NMI)
- APIC internal errors

The APIC timer, thermal events, performance counters, local interrupts, and internal errors are all considered local interrupt sources, and their routing is controlled by local vector table entries. These entries assign a message type and vector to each interrupt, allow them to be masked, and track the status of the interrupt.

IO and inter-processor interrupts have their message type and vector assigned at the source and are unaltered by the local APIC. They carry a destination field and a mode bit that together determine which local APIC(s) accepts them. The destination mode (DM) bit specifies if the interrupt request packet should be handled in physical or logical destination mode. If the destination field matches the broadcast value specified by [D18F0x68](#)[ApicExtBrdCst], then the interrupt is a broadcast interrupt and is accepted by all local APICs regardless of destination mode.

#### 2.4.9.1.1 Detecting and Enabling

APIC is detected and enabled via [CPUID Fn0000\\_0001\\_EDX](#)[APIC].

The local APIC is enabled via [MSR0000\\_001B](#)[ApicEn]. Reset forces APIC disabled.

#### 2.4.9.1.2 APIC Register Space

MMIO APIC space:

- Memory mapped to a 4 KB range. The memory type of this space is the UC memory type. The base address of this range is specified by {[MSR0000\\_001B](#)[ApicBar[47:12]], 000h}.
- The mnemonic is defined to be APICXX; XX is the byte address offset from the base address.
- MMIO APIC registers in xAPIC mode is defined by the register from [APIC20](#) to [APIC\[530:500\]](#).
- Treated as normal memory space when APIC is disabled, as specified by [MSR0000\\_001B](#)[ApicEn].

#### 2.4.9.1.3 ApicId Enumeration Requirements

System hardware and BIOS must ensure that the number of cores per processor (NC) exposed to the operating system by all tables, registers, and instructions across all cores in the processor is identical. See [2.4.11.1 \[Multi-Core Support\]](#) to derive NC.

Operating systems are expected to use [CPUID Fn8000\\_0008\\_ECX](#)[ApicIdCoreIdSize], the number of least significant bits in the Initial APIC ID that indicate core ID within a processor, in constructing per-core CPUID masks. (ApicIdCoreIdSize[3:0] determines the maximum number of cores (MNC) that the processor could theoretically support, not the actual number of cores that are actually implemented or enabled on the processor, as indicated by [CPUID Fn8000\\_0008\\_ECX](#)[NC].)  $MNC = (2 \wedge \text{CPUID Fn8000\_0008\_ECX}[\text{ApicIdCoreIdSize}])$ .

BIOS must use the ApicId MNC rule when assigning [APIC20\[ApicId\]](#) values as described below.

ApicId MNC rule: The ApicId of core j on processor i must be enumerated/assigned as:

- $\text{ApicId}[\text{proc}=i, \text{core}=j] = (\text{OFFSET\_IDX} + i) * \text{MNC} + j$
- Where OFFSET\_IDX is an integer offset (0 to N) used to shift up the core ApicId values to allow room for IOAPIC devices.

It is recommended that BIOS use the following APIC ID assignments for the broadest operating system support. Given  $N = (\text{Number\_Of\_Processors} * \text{MNC})$  and  $M = \text{Number\_Of\_IOAPICs}$ :

- If  $(N+M) < 16$ , then assign the local (core) ApicIds first from 0 to N-1, and the IOAPIC IDs from N to N+(M-1). APIC ID 15 is reserved for broadcast when [APIC410\[ExtApicIdEn\]](#)==0.
- If  $(N+M) \geq 16$ , then assign the IOAPIC IDs first from 0 to M-1, and the local (core) ApicIds from K to K+(N-1), where K is an integer multiple of MNC greater than M-1.

#### 2.4.9.1.4 Physical Destination Mode

The interrupt is only accepted by the local APIC whose [APIC20\[ApicId\]](#) matches the destination field of the interrupt. Physical mode allows up to 255 APICs to be addressed individually.

#### 2.4.9.1.5 Logical Destination Mode

A local APIC accepts interrupts selected by [APICD0 \[Logical Destination \(LDR\)\]](#) and the destination field of the interrupt using either cluster or flat format as configured by [APICE0\[Format\]](#).

If flat destinations are in use, bits 7-0 of [APICD0\[Destination\]](#) are checked against bits 7-0 of the arriving interrupt's destination field. If any bit position is set in both fields, the local APIC is a valid destination. Flat format allows up to 8 APICs to be addressed individually.

If cluster destinations are in use, bits 7-4 of [APICD0\[Destination\]](#) are checked against bits 7-4 of the arriving interrupt's destination field to identify the cluster. If all of bits 7-4 match, then bits 3-0 of [APICD0\[Destination\]](#) and the interrupt destination are checked for any bit positions that are set in both fields to identify processors within the cluster. If both conditions are met, the local APIC is a valid destination. Cluster format allows 15 clusters of 4 APICs each to be addressed.

#### 2.4.9.1.6 Interrupt Delivery

SMI, NMI, INIT, Startup, and External interrupts are classified as non-vectorized interrupts.

When an APIC accepts a non-vectorized interrupt, it is handled directly by the processor instead of being queued in the APIC. When an APIC accepts a fixed or lowest-priority interrupt, it sets the bit in [APIC\[270:200\] \[Interrupt Request \(IRR\)\]](#) corresponding to the vector in the interrupt. For local interrupt sources, this comes from the vector field in that interrupt's local vector table entry. The corresponding bit in [APIC\[1F0:180\] \[Trigger Mode \(TMR\)\]](#) is set if the interrupt is level-triggered and cleared if edge-triggered. If a subsequent interrupt with the same vector arrives when the corresponding bit in [APIC\[270:200\]\[RequestBits\]](#) is already set, the two interrupts are collapsed into one. Vectors 15-0 are reserved.

#### 2.4.9.1.7 Vectored Interrupt Handling

[APIC80 \[Task Priority \(TPR\)\]](#) and [APICA0 \[Processor Priority \(PPR\)\]](#) each contain an 8-bit priority divided into a main priority (bits 7-4) and a priority sub-class (bits 3-0). The task priority is assigned by software to set a threshold priority at which the processor is interrupted.



The processor priority is calculated by comparing the main priority (bits 7-4) of [APIC80\[Priority\]](#) to bits 7-4 of the 8-bit encoded value of the highest bit set in [APIC\[170:100\] \[In-Service \(ISR\)\]](#). The processor priority is the higher of the two main priorities.

The processor priority is used to determine if any accepted interrupts (indicated by [APIC\[270:200\]\[Request-Bits\]](#)) are high enough priority to be serviced by the processor. When the processor is ready to service an interrupt, the highest bit in [APIC\[270:200\]\[RequestBits\]](#) is cleared, and the corresponding bit is set in [APIC\[170:100\]\[InServiceBits\]](#).

When the processor has completed service for an interrupt, it performs a write to [APICB0 \[End of Interrupt\]](#), clearing the highest bit in [APIC\[170:100\]\[InServiceBits\]](#) and causing the next-highest interrupt to be serviced. If the corresponding bit in [APIC\[1F0:180\]\[TriggerModeBits\]](#) is set, a write to [APICB0](#) is performed on all APICs to complete service of the interrupt at the source.

#### 2.4.9.1.8 Interrupt Masking

Interrupt masking is controlled by the [APIC410 \[Extended APIC Control\]](#). If [APIC410\[IerEn\]](#) is set, [APIC\[4F0:480\] \[Interrupt Enable\]](#) are used to mask interrupts. Any bit in [APIC\[4F0:480\]\[InterruptEnableBits\]](#) that is clear indicates the corresponding interrupt is masked. A masked interrupt is not serviced and the corresponding bit in [APIC\[270:200\]\[RequestBits\]](#) remains set.

#### 2.4.9.1.9 Spurious Interrupts

In the event that the task priority is set to or above the level of the interrupt to be serviced, the local APIC delivers a spurious interrupt vector to the processor, as specified by [APICF0 \[Spurious-Interrupt Vector \(SVR\)\]](#). [APIC\[170:100\]](#) is not changed and no write to [APICB0](#) occurs.

#### 2.4.9.1.10 Spurious Interrupts Caused by Timer Tick Interrupt

A typical interrupt is asserted until it is serviced. An interrupt is deasserted when software clears the interrupt status bit within the interrupt service routine. Timer tick interrupt is an exception, since it is deasserted regardless of whether it is serviced or not.

The processor is not always able to service interrupts immediately (i.e. when interrupts are masked by clearing [EFLAGS.IM](#)).

If the processor is not able to service the timer tick interrupt for an extended period of time, the INTR caused by the first timer tick interrupt asserted during that time is delivered to the local APIC in ExtInt mode and latched, and the subsequent timer tick interrupts are lost. The following cases are possible when the processor is ready to service interrupts:

- An ExtInt interrupt is pending, and INTR is asserted. This results in timer tick interrupt servicing. This occurs 50 percent of the time.
- An ExtInt interrupt is pending, and INTR is deasserted. The processor sends the interrupt acknowledge cycle, but when the PIC receives it, INTR is deasserted, and the PIC sends a spurious interrupt vector. This occurs 50 percent of the time.

There is a 50 percent probability of spurious interrupts to the processor.

#### 2.4.9.1.11 Lowest-Priority Interrupt Arbitration

Fixed, remote read, and non-vectored interrupts are accepted by their destination APICs without arbitration.

Delivery of lowest-priority interrupts requires all APICs to arbitrate to determine which one accepts the interrupt. If [APICF0\[FocusDisable\]](#) is clear, then the focus processor for an interrupt always accepts the interrupt. A processor is the focus of an interrupt if it is already servicing that interrupt (corresponding bit in [APIC\[170:100\]\[InServiceBits\]](#) is set) or if it already has a pending request for that interrupt (corresponding bit in [APIC\[270:200\]\[RequestBits\]](#) is set). If [APIC410\[IerEn\]](#) is set the interrupt must also be enabled in [APIC\[4F0:480\]\[InterruptEnableBits\]](#) for a processor to be the focus processor. If there is no focus processor for an interrupt, or focus processor checking is disabled, then each APIC calculates an arbitration priority value, stored in [APIC90 \[Arbitration Priority \(APR\)\]](#), and the one with the lowest result accepts the interrupt.

The arbitration priority value is calculated by comparing [APIC80\[Priority\]](#) with the 8-bit encoded value of the highest bit set in [APIC\[270:200\]\[RequestBits\]](#) (IRRVec) and the 8-bit encoded value of the highest bit set [APIC\[170:100\]\[InServiceBits\]](#) (ISRVec). If [APIC410\[IerEn\]](#) is set the IRRVec and ISRVec are based off the highest enabled interrupt. The main priority bits 7-4 are compared as follows:

```
IF ((APIC80[Priority[7:4]] >= IRRVec[7:4]) && (APIC80[Priority[7:4]] > ISRVec[7:4])) THEN
    APIC90[Priority] = APIC80[Priority]
ELSEIF (IRRVec[7:4] > ISRVec[7:4]) THEN
    APIC90[Priority] = {IRRVec[7:4],0h}
ELSE
    APIC90[Priority] = {ISRVec[7:4],0h}
ENDIF.
```

#### 2.4.9.1.12 Inter-Processor Interrupts

[APIC300 \[Interrupt Command Low \(ICR Low\)\]](#) and [APIC310 \[Interrupt Command High \(ICR High\)\]](#) provide a mechanism for generating interrupts in order to redirect an interrupt to another processor, originate an interrupt to another processor, or allow a processor to interrupt itself. A write to register [APIC300](#) causes an interrupt to be generated with the properties specified by the [APIC300](#) and [APIC310](#) fields.

#### 2.4.9.1.13 APIC Timer Operation

The local APIC contains a 32-bit timer, controlled by [APIC320 \[LVT Timer\]](#), [APIC380 \[Timer Initial Count\]](#), and [APIC3E0 \[Timer Divide Configuration\]](#). The processor bus clock is divided by the value in [APIC3E0\[Div\]](#) to obtain a time base for the timer. When [APIC380\[Count\]](#) is written, the value is copied into [APIC390 \[Timer Current Count\]](#). [APIC390\[Count\]](#) is decremented at the rate of the divided clock. When the count reaches 0, a timer interrupt is generated with the vector specified in [APIC320\[Vector\]](#). If [APIC320\[Mode\]](#) specifies periodic operation, [APIC390\[Count\]](#) is reloaded with the [APIC380\[Count\]](#) value, and it continues to decrement at the rate of the divided clock. If [APIC320\[Mask\]](#) is set, timer interrupts are not generated.

#### 2.4.9.1.14 Generalized Local Vector Table

All LVTs ([APIC330](#) to [APIC3\[60:50\]](#), and [APIC\[530:500\]](#)) support a generalized message type as follows:

- 000b=Fixed
- 010b=SMI
- 100b=NMI
- 111b=ExtINT
- All other messages types are reserved.

#### 2.4.9.1.15 State at Reset

At power-up or reset, the APIC is hardware disabled ([MSR0000\\_001B\[ApicEn\]=0](#)) so only SMI, NMI, INIT, and ExtInt interrupts may be accepted.



The APIC can be software disabled through [APICF0\[APICSWEn\]](#). The software disable has no effect when the APIC is hardware disabled.

When a processor accepts an INIT interrupt, the APIC is reset as at power-up, with the exception that:

- [APIC20\[ApicId\]](#) is unaffected.
- Pending APIC register writes complete.

## 2.4.9.2 System Management Mode (SMM)

System management mode (SMM) is typically used for system control activities such as power management. These activities are typically transparent to the operating system.

### 2.4.9.2.1 SMM Overview

SMM is entered by a core on the next instruction boundary after a system management interrupt (SMI) is received and recognized. A core may be programmed to broadcast a special cycle to the system, indicating that it is entering SMM mode. The core then saves its state into the SMM memory state save area and jumps to the SMI service routine (or SMI handler). The pointer to the SMI handler is specified by MSRs. The code and data for the SMI handler are stored in the SMM memory area, which may be isolated from the main memory accesses.

The core returns from SMM by executing the RSM instruction from the SMI handler. The core restores its state from the SMM state save area and resumes execution of the instruction following the point where it entered SMM. The core may be programmed to broadcast a special bus cycle to the system, indicating that it is exiting SMM mode.

### 2.4.9.2.2 Operating Mode and Default Register Values

The software environment after entering SMM has the following characteristics:

- Addressing and operation is in Real mode.
  - A far jump, call or return in the SMI handler can only address the lower 1M of memory, unless the SMI handler first switches to protected mode.
  - If ([MSRC001\\_0111\[SmmBase\]](#) >= 0010\_0000h) then:
    - The value of the CS selector is undefined upon SMM entry.
    - The undefined CS selector value should not be used as the target of a far jump, call, or return.
- 4-Gbyte segment limits.
- Default 16-bit operand, address, and stack sizes (instruction prefixes can override these defaults).
- Control transfers that do not override the default operand size truncate the EIP to 16 bits.
- Far jumps or calls cannot transfer control to a segment with a base address requiring more than 20 bits, as in Real mode segment-base addressing, unless a change is made into protected mode.
- A20M# is disabled. A20M# assertion or deassertion have no affect during SMM.
- Interrupt vectors use the Real mode interrupt vector table.
- The IF flag in EFLAGS is cleared (INTR is not recognized).
- The TF flag in EFLAGS is cleared.
- The NMI and INIT interrupts are masked.
- Debug register DR7 is cleared (debug traps are disabled).

The SMM base address is specified by [MSRC001\\_0111\[SmmBase\]](#). Important offsets to the base address pointer are:

- [MSRC001\\_0111\[SmmBase\]](#) + 8000h: SMI handler entry point.
- [MSRC001\\_0111\[SmmBase\]](#) + FE00h - FFFFh: SMM state save area.

### 2.4.9.2.3 SMI Sources And Delivery

The processor accepts SMIs as link-defined interrupt messages only. The core/node destination of these SMIs is a function of the destination field of these messages. However, the expectation is that all such SMI messages are specified to be delivered globally (to all cores of all nodes).

There are also several local events that can trigger SMIs. However, these local events do not generate SMIs directly. Each of them triggers a programmable IO cycle that is expected to target the SMI command port in the IO hub and trigger a global SMI interrupt message back to the coherent fabric.

Local sources of SMI events that generate the IO cycle specified in [MSRC001\\_0056 \[SMI Trigger IO Cycle\]](#) are:

- In the core, as specified by:
  - [MSRC001\\_0022 \[Machine Check Exception Redirection\]](#).
  - [MSRC001\\_00\[53:50\] \[IO Trap \(SMI\\_ON\\_IO\\_TRAP\\_\[3:0\]\)\]](#).
- All local APIC LVT registers programmed to generate SMIs.

The status for these is stored in [SMMFEC4](#).

### 2.4.9.2.4 SMM Initial State

After storing the save state, execution starts at [MSRC001\\_0111\[SmmBase\]](#) + 08000h. The SMM initial state is specified in the following table.

**Table 7: SMM Initial State**

Register	SMM Initial State
CS	SmmBase[19:4]
DS	0000h
ES	0000h
FS	0000h
GS	0000h
SS	0000h
General-Purpose Registers	Unmodified
EFLAGS	0000_0002h
RIP	0000_0000_0000_8000h
CR0	Bits 0, 2, 3, and 31 cleared (PE, EM, TS, and PG); remainder is unmodified
CR4	0000_0000_0000_0000h
GDTR	Unmodified
LDTR	Unmodified
IDTR	Unmodified
TR	Unmodified
DR6	Unmodified
DR7	0000_0000_0000_0400h
EFER	All bits are cleared except bit 12 (SVME) which is unmodified.

### 2.4.9.2.5 SMM Save State

In the following table, the offset field provides the offset from the SMM base address specified by [MSRC001\\_0111 \[SMM Base Address \(SMM\\_BASE\)\]](#).

**Table 8: SMM Save State**

Offset	Size	Contents		Access
FE00h	Word	ES	Selector	Read-only
FE02h	6 Bytes		Reserved	
FE08h	Quadword		Descriptor in memory format	
FE10h	Word	CS	Selector	Read-only
FE12h	6 Bytes		Reserved	
FE18h	Quadword		Descriptor in memory format	
FE20h	Word	SS	Selector	Read-only
FE22h	6 Bytes		Reserved	
FE28h	Quadword		Descriptor in memory format	
FE30h	Word	DS	Selector	Read-only
FE32h	6 Bytes		Reserved	
FE38h	Quadword		Descriptor in memory format	
FE40h	Word	FS	Selector	Read-only
FE42h	2 Bytes		Reserved	
FE44h	Doubleword		FS Base {16'b[47], 47:32} <sup>1</sup>	
FE48h	Quadword		Descriptor in memory format	
FE50h	Word	GS	Selector	Read-only
FE52h	2 Bytes		Reserved	
FE54h	Doubleword		GS Base {16'b[47], 47:32} <sup>1</sup>	
FE58h	Quadword		Descriptor in memory format	
FE60h	4 Bytes	GDTR	Reserved	Read-only
FE64h	Word		Limit	
FE66h	2 Bytes		Reserved	
FE68h	Quadword		Descriptor in memory format	
FE70h	Word	LDTR	Selector	Read-only
FE72h	Word		Attributes	
FE74h	Doubleword		Limit	
FE78h	Quadword		Base	
FE80h	4 Bytes	IDTR	Reserved	Read-only
FE84h	Word		Limit	
FEB6h	2 Bytes		Reserved	
FE88h	Quadword		Base	

**Table 8: SMM Save State**

Offset	Size	Contents		Access
FE90h	Word	TR	Selector	Read-only
FE92h	Word		Attributes	
FE94h	Doubleword		Limit	
FE98h	Quadword		Base	
FEA0h	Quadword	IO_RESTART_RIP		Read-only
FEA8h	Quadword	IO_RESTART_RCX		
FEB0h	Quadword	IO_RESTART_RSI		
FEB8h	Quadword	IO_RESTART_RDI		
FEC0h	Doubleword	SMMFEC0 [SMM IO Trap Offset]		Read-only
FEC4	Doubleword	SMMFEC4 [Local SMI Status]		Read-only
FEC8h	Byte	SMMFEC8 [SMM IO Restart Byte]		Read-write
FEC9h	Byte	SMMFEC9 [Auto Halt Restart Offset]		Read-write
FECAh	Byte	SMMFECA [NMI Mask]		Read-write
FECBh	5 Bytes	Reserved		
FED0h	Quadword	EFER		Read-only
FED8h	Quadword	SMMFED8 [SMM SVM State]		Read-only
FEE0h	Quadword	Guest VMCB physical address		Read-only
FEE8h	Quadword	SVM Virtual Interrupt Control		Read-only
FEF0h	16 Bytes	Reserved		
FEFCh	Doubleword	SMMFEFC [SMM-Revision Identifier]		Read-only
FF00h	Doubleword	SMMFF00 [SMM Base Address (SMM_BASE)]		Read-write
FF04h	28 Bytes	Reserved		
FF20h	Quadword	Guest PAT		Read-only
FF28h	Quadword	Host EFER <sup>2</sup>		
FF30h	Quadword	Host CR4 <sup>2</sup>		
FF38h	Quadword	Nested CR3 <sup>2</sup>		
FF40h	Quadword	Host Cr0 <sup>2</sup>		
FF48h	Quadword	CR4		
FF50h	Quadword	CR3		
FF58h	Quadword	CR0		
FF60h	Quadword	DR7		
FF68h	Quadword	DR6		Read-only
FF70h	Quadword	RFLAGS		Read-write

**Table 8: SMM Save State**

Offset	Size	Contents	Access
FF78h	Quadword	RIP	Read-write
FF80h	Quadword	R15	
FF88h	Quadword	R14	
FF90h	Quadword	R13	
FF98h	Quadword	R12	
FFA0h	Quadword	R11	
FFA8h	Quadword	R10	
FFB0h	Quadword	R9	
FFB8h	Quadword	R8	
FFC0h	Quadword	RDI	Read-write
FFC8h	Quadword	RSI	
FFD0h	Quadword	RBP	
FFD8h	Quadword	RSP	
FFE0h	Quadword	RBX	
FFE8h	Quadword	RDX	
FFF0h	Quadword	RCX	
FFF8h	Quadword	RAX	

Notes:

1. This notation specifies that bit[47] is replicated in each of the 16 MSBs of the DW (sometimes called *sign extended*). The 16 LSB's contain bits[47:32].
2. Only used for an SMI in guest mode with nested paging enabled.

The SMI save state includes most of the integer execution unit. Not included in the save state are: the floating point state, MSRs, and CR2. In order to be used by the SMI handler, these must be saved and restored. The save state is the same, regardless of the operating mode (32-bit or 64-bit).

The following are some offsets in the SMM save state area. The mnemonic for each offset is in the form SMMxxxx, where xxxx is the offset in the save state.

### SMMFEC0 SMM IO Trap Offset

If the assertion of SMI is recognized on the boundary of an IO instruction, [SMMFEC0 \[SMM IO Trap Offset\]](#) contains information about that IO instruction. For example, if an IO access targets an unavailable device, the system can assert SMI and trap the IO instruction. [SMMFEC0](#) then provides the SMI handler with information about the IO instruction that caused the trap. After the SMI handler takes the appropriate action, it can reconstruct and then re-execute the IO instruction from SMM. Or, more likely, it can use [SMMFEC8 \[SMM IO Restart Byte\]](#), to cause the core to re-execute the IO instruction immediately after resuming from SMM.

Bits	Description
31:16	<b>Port: trapped IO port address.</b> Read-only. This provides the address of the IO instruction.
15:12	<b>BPR: IO breakpoint match.</b> Read-only.
11	<b>TF: EFLAGS TF value.</b> Read-only.

10:7	Reserved.
6	<b>SZ32: size 32 bits.</b> Read-only. 1=Port access was 32 bits.
5	<b>SZ16: size 16 bits.</b> Read-only. 1= Port access was 16 bits.
4	<b>SZ8: size 8 bits.</b> Read-only. 1=Port access was 8 bits.
3	<b>REP: repeated port access.</b> Read-only.
2	<b>STR: string-based port access.</b> Read-only.
1	<b>V: IO trap word valid.</b> Read-only. 1=The core entered SMM on an IO instruction boundary; all information in this offset is valid. 0=The other fields of this offset are not valid.
0	<b>RW: port access type.</b> Read-only. 0=IO write (OUT instruction). 1=IO read (IN instruction).

### SMMFEC4 Local SMI Status

This offset stores status bits associated with SMI sources local to the core. For each of these bits, 1=The associated mechanism generated an SMI.

Bits	Description
31:20	Reserved.
19	<b>SmiSrcThrCntHt: SMI source link thresholding.</b> Read-only. This bit is associated with the SMI source specified in the link thresholding register (see <a href="#">MSR0000_0403 [MC0 Machine Check Miscellaneous (MC0_MISC)]</a> ).
18	<b>SmiSrcThrCntDram: SMI source DRAM thresholding.</b> Read-only. This bit is associated with the SMI source specified in the DRAM thresholding register (see <a href="#">D18F3x160 [NB Machine Check Misc (DRAM Thresholding) 0 (MC4_MISC0)]</a> ).
17	<b>SmiSrcLvtExt: SMI source LVT extended entry.</b> Read-only. This bit is associated with the SMI sources specified in <a href="#">APIC[530:500] [Extended Interrupt [3:0] Local Vector Table]</a> .
16	<b>SmiSrcLvtLcy: SMI source LVT legacy entry.</b> Read-only. This bit is associated with the SMI sources specified by the non-extended LVT entries of the APIC.
15:11	Reserved.
10	<b>IntPendSmiSts: interrupt pending SMI status.</b> Read-only. This bit is associated with the SMI source specified when ( <a href="#">MSRC001_0055[IntPndMsg]</a> ==1).
9	Reserved.
8	<b>MceRedirSts: machine check exception redirection status.</b> Read-only. This bit is associated with the SMI source specified in <a href="#">MSRC001_0022[RedirSmiEn]</a> .
7:4	Reserved.
3:0	<b>IoTrapSts: IO trap status.</b> Read-only. Each of these bits is associated with each of the respective SMI sources specified in <a href="#">MSRC001_00[53:50] [IO Trap (SMI_ON_IO_TRAP_[3:0])]</a> .

### SMMFEC8 SMM IO Restart Byte

00h on entry into SMM.

If the core entered SMM on an IO instruction boundary, the SMI handler may write this to FFh. This causes the core to re-execute the trapped IO instruction immediately after resuming from SMM. The SMI handler should only write to this byte if [SMMFEC0](#) field V==1; otherwise, the behavior is undefined.

If a second SMI is asserted while a valid IO instruction is trapped by the first SMI handler, the core services the second SMI prior to re-executing the trapped IO instruction. **SMMFEC0** field V==0 during the second entry into SMM, and the second SMI handler must not rewrite this byte.

If there is a simultaneous SMI IO instruction trap and debug breakpoint trap, the processor first responds to the SMI and postpones recognizing the debug exception until after resuming from SMM. If debug registers other than DR6 and DR7 are used while in SMM, they must be saved and restored by the SMI handler. If **SMMFEC8 [SMM IO Restart Byte]**, is set to FFh when the RSM instruction is executed, the debug trap does not occur until after the IO instruction is re-executed.

Bits	Description
7:0	<b>RST: SMM IO Restart Byte.</b> Read-write.

### SMMFEC9 Auto Halt Restart Offset

Bits	Description
7:1	Reserved.
0	<b>HLT: halt restart.</b> Read-write. Upon SMM entry, this bit indicates whether SMM was entered from the Halt state. 0=Entered SMM on a normal x86 instruction boundary. 1=Entered SMM from the Halt state. Before returning from SMM, this bit can be written by the SMI handler to specify whether the return from SMM should take the processor back to the Halt state or to the instruction-execution state specified by the SMM state save area (normally, the instruction after the halt). 0=Return to the instruction specified in the SMM save state. 1=Return to the halt state. If the return from SMM takes the processor back to the Halt state, the HLT instruction is not refetched and re-executed. However, the Halt special bus cycle is broadcast and the processor enters the Halt state.

### SMMFECA NMI Mask

Bits	Description
7:1	Reserved.
0	<b>NmiMask.</b> Read-write. Specifies whether NMI was masked upon entry to SMM. 0=NMI not masked. 1=NMI masked.

### SMMFED8 SMM SVM State

Read-only. This offset stores the SVM state of the processor upon entry into SMM.

Bits	Description
63:4	Reserved.

3	<b>HostEflagsIf: host Eflags IF.</b>														
2:0	<b>SvmState.</b> <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>000b</td><td>SMM entered from a non-guest state.</td></tr> <tr> <td>001b</td><td>Reserved.</td></tr> <tr> <td>010b</td><td>SMM entered from a guest state.</td></tr> <tr> <td>101b-011b</td><td>Reserved.</td></tr> <tr> <td>110b</td><td>SMM entered from a guest state with nested paging enabled.</td></tr> <tr> <td>111b</td><td>Reserved.</td></tr> </table>	Bits	Definition	000b	SMM entered from a non-guest state.	001b	Reserved.	010b	SMM entered from a guest state.	101b-011b	Reserved.	110b	SMM entered from a guest state with nested paging enabled.	111b	Reserved.
Bits	Definition														
000b	SMM entered from a non-guest state.														
001b	Reserved.														
010b	SMM entered from a guest state.														
101b-011b	Reserved.														
110b	SMM entered from a guest state with nested paging enabled.														
111b	Reserved.														

### SMMFEFC SMM-Revision Identifier

SMM entry state: 0003\_0064h

Bits	Description
31:18	Reserved.
17	<b>BRL.</b> Read-only. Base relocation supported.
16	<b>IOTrap.</b> Read-only. IO trap supported.
15:0	<b>Revision.</b> Read-only.

### SMMFF00 SMM Base Address (SMM\_BASE)

Bits	Description
31:0	See: <a href="#">MSRC001_0111</a> [SmmBase].

#### 2.4.9.2.6 Exceptions and Interrupts in SMM

When SMM is entered, the core masks INTR, NMI, SMI, INIT, and A20M interrupts. The core clears the IF flag to disable INTR interrupts. To enable INTR interrupts within SMM, the SMM handler must set the IF flag to 1. A20M is disabled so that address bit 20 is never masked when in SMM.

Generating an INTR interrupt can be used for unmasking NMI interrupts in SMM. The core recognizes the assertion of NMI within SMM immediately after the completion of an IRET instruction. Once NMI is recognized within SMM, NMI recognition remains enabled until SMM is exited, at which point NMI masking is restored to the state it was in before entering SMM.

While in SMM, the core responds to the DBREQ and STPCLK interrupts, as well as to all exceptions that may be caused by the SMI handler.

#### 2.4.9.2.7 The Protected ASeg and TSeg Areas

These ranges are controlled by [MSRC001\\_0112](#) and [MSRC001\\_0113](#); see those registers for details.

#### 2.4.9.2.8 SMM Special Cycles

Special cycles can be initiated on entry and exit from SMM to acknowledge to the system that these transitions are occurring. These are controlled by [MSRC001\\_0015](#)[RsmSpCycDis, SmiSpCycDis].



### 2.4.9.2.9 Locking SMM

The SMM registers ([MSRC001\\_0112](#) and [MSRC001\\_0113](#)) can be locked from being altered by setting [MSRC001\\_0015](#)[SmmLock]. SBIOS must lock the SMM registers after initialization to prevent unexpected changes to these registers.

### 2.4.9.2.10 Synchronizing SMM Entry (Spring-Boarding)

The BIOS must take special care to ensure that all cores have entered SMM prior to accessing shared IO resources and all core SMI interrupt status bits are synchronized. This generally requires that BIOS waits for all cores to enter SMM.

The following conditions can cause one or more cores to enter SMM without all cores entering SMM:

- More than one IO device in the system is enabled to signal an SMI without hardware synchronization (e.g. using an end of SMI gate).
- A single device may signal multiple SMI messages without hardware synchronization (e.g. using an end of SMI gate).
- An SMI is received while one or more AP cores are in the INIT state. This may occur either during BIOS or secure boot.
- A hardware error prevents a core from entering SMM.

The act of synchronizing cores into SMM is called spring-boarding. Because not all of the above conditions can be avoided, it is recommended that all systems support spring-boarding.

An ACPI-compliant IO hub is required for spring-boarding. Depending on the IO hub design, BIOS may have to set additional end-of-SMI bits to trigger an SMI from within SMM.

The software requirements for the suggested spring-boarding implementation are listed as follows.

- A binary semaphore located in SMRAM, accessible by all cores. For the purpose of this discussion, the semaphore is called CheckSpringBoard. CheckSpringBoard is initialized to zero.
- Two semaphores located in SMRAM, accessible by all cores. For the purpose of this discussion, the semaphores are called NotInSMM and WaitInSMM. NotInSMM and WaitInSMM are initialized to a value equal to the number of cores in the system (NumCPUs).

The following BIOS algorithm describes spring-boarding and is optimized to reduce unnecessary SMI activity. This algorithm must be made part of the SMM instruction sequence for each core in the system.

1. Attempt to obtain ownership of the CheckSpringBoard semaphore with a read-modify-write instruction. If ownership was obtained then do the following, else proceed to step 2:
    - Check all enabled SMI status bits in the IO hub.  
Let Status=enable1&status1 | enable2&status2 | enable3&status3 ... enable n & status n.
    - If (Status==0) then perform the following sub-actions.
      - Trigger an SMI broadcast assertion from the IO hub by writing to the software SMI command port.
      - Resume from SMM with the RSM instruction.
- //Example:
- ```
InLineASM{
    BTS CheckSpringBoard,0; Try to obtain ownership of semaphore
    JC Step_2:
    CALL CheckIOHUB_SMIEVT; proc returns ZF=1 for no events
    JNZ Step_2:
    CALL Do_SpringBoard;Trigger SMI and then RSM
```

```

    Step_2:
}

```

2. Decrement the NotInSMM variable. Wait for (NotInSMM==0). See Note 1.
3. Execute the core-local event SMI handler. Using a third semaphore (not described here), synchronize core execution at the end of the task. After all cores have executed, proceed to step 4. The following is a brief description of the task for each core:
  - Check all enabled core-local SMI status bits in the core's private or MSR address space. Handle the event if possible, or pass information necessary to handle the event to a mailbox for the BSC to handle.
  - An exclusive mailbox must exist for each core for each core local event.
  - Wait for all cores to complete this task at least once.
4. If the current core executing instructions is not the BSC then jump to step 5. If the core executing instructions is the BSC then jump to the modified main SMI handler task, described below.
  - Check all enabled SMI status bits in the IO hub. Check mailboxes for event status.
  - For each event, handle the event and clear the corresponding status bit.
  - Repeat until all enabled SMI status bits are clear and no mailbox events remain.
  - Set NotInSMM=NumCPUs. (Jump to step 5.)
5. Decrement the WaitInSMM variable. Wait for WaitInSMM=0. See Note 2.
6. Increment the WaitInSMM variable. Wait for WaitInSMM=NumCPUs.
7. If the current processor core executing instructions is the BSC then reset CheckSpringBoard to zero.
8. Resume from SMM with the RSM instruction.

#### Notes:

1. To support a secure startup by the secure loader the BIOS must provide a timeout escape from the otherwise endless loop. The timeout value should be large enough to account for the latency of all cores entering SMM. The maximum SMM entrance latency is defined by the platform's IO sub-system, not the processor. A value of twice the watchdog timer count is recommended. See [D18F3x44 \[MCA NB Configuration\]](#) for more information on the watchdog time-out value. If a time-out occurs in the wait loop, the BIOS (the last core to decrement NotInSMM) should record the number of cores that have not entered SMM and all cores must fall out of the loop.
2. If a time-out occurs in the wait loop in step 2, the BIOS must not wait for WaitInSMM=0. Instead it must wait for WaitInSMM=(the number of cores recorded in step 2).
3. If BIOS places APs in the INIT state during any part of the boot process when SMIs may be generated, or may generate SMIs before taking all APs out of their initial microcode reset loop (i.e., before [D18F0x1DC\[CpuEn\]](#) is set), then it is recommended that BIOS keep a record of how many APs are in these two states and exclude these cores from the wait loops. SMIs are not recognized by a processor in these states. AMD does not recommend enabling SMI sources prior to bringing all APs out of these states.

### 2.4.10 Secure Virtual Machine Mode (SVM)

Support for SVM mode is indicated by [CPUID Fn8000\\_0001\\_ECX\[SVM\]](#).

#### 2.4.10.1 BIOS support for SVM Disable

The BIOS should include the following user setup options to enable and disable AMD Virtualization™ technology.

- Enable AMD Virtualization™.
  - [MSRC001\\_0114\[SvmeDisable\]](#) = 0.
  - [MSRC001\\_0114\[Lock\]](#) = 1.
  - [MSRC001\\_0118\[SvmLockKey\]](#) = 0000\_0000\_0000\_0000h.
- Disable AMD Virtualization™.

- [MSRC001\\_0114](#)[SvmeDisable]=1.
- [MSRC001\\_0114](#)[Lock]=1.
- [MSRC001\\_0118](#)[SvmLockKey] = 0000\_0000\_0000\_0000h.

The BIOS may also include the following user setup options to disable AMD Virtualization™ technology.

- Disable AMD Virtualization™, with a user supplied key.
  - [MSRC001\\_0114](#)[SvmeDisable]=1.
  - [MSRC001\\_0114](#)[Lock]=1.
  - [MSRC001\\_0118](#)[SvmLockKey] programmed with value supplied by user. This value should be stored in NVRAM.

## 2.4.11 CPUID Instruction

The CPUID instruction provides data about the features supported by the processor. See [3.18 \[CPUID Instruction Registers\]](#).

### 2.4.11.1 Multi-Core Support

There are two methods for determining multi-core support. A recommended mechanism is provided and a legacy method is also available for existing operating systems. System software should use the correct architectural mechanism to detect the number of physical cores by observing [CPUID Fn8000\\_0008\\_ECX](#)[NC]. The legacy method utilizes the [CPUID Fn0000\\_0001\\_EBX](#)[LogicalProcessorCount].

## 2.5 Power Management

The processor supports many power management features in a variety of systems. [Table 9](#) provides a summary of ACPI states and power management features and indicates whether they are supported.

**Table 9: Power Management Support**

| ACPI/Power Management State              | Supported | Description                                                                                |
|------------------------------------------|-----------|--------------------------------------------------------------------------------------------|
| G0/S0/C0: Working                        | Yes       |                                                                                            |
| G0/S0/C0: Core P-state transitions       | Yes       | <a href="#">2.5.3.1 [Core P-states]</a>                                                    |
| G0/S0/C0: NB P-state transitions         | Yes       | <a href="#">2.5.4.1 [NB P-states]</a>                                                      |
| G0/S0/C0: Hardware thermal control (HTC) | Yes       | <a href="#">2.10.3.1 [PROCHOT_L and Hardware Thermal Control (HTC)]</a>                    |
| G0/S0/Per-core IO-based C-states         | Yes       | <a href="#">2.5.3.2 [Core C-states]</a> and <a href="#">2.5.1.3.2 [Low Power Voltages]</a> |
| G0/S0/C1: Halt                           | Yes       |                                                                                            |
| G0/S0/CC6: Per-compute unit Power gating | Yes       | <a href="#">2.5.3.2 [Core C-states]</a>                                                    |
| G0/S0/CC6: L2 power gating               | Yes       | <a href="#">2.5.3.2 [Core C-states]</a>                                                    |
| G0/S0/PC6: 0V support (VDD power plane). | Yes       | <a href="#">2.5.3.2 [Core C-states]</a> and <a href="#">2.5.1.3.2 [Low Power Voltages]</a> |
| G0/S0/Cx: Cache flushing support         | Yes       | <a href="#">2.5.3.2.3.1 [C-state Probes and Cache Flushing]</a>                            |
| G0/S0: Northbridge C-states              | Yes       | <a href="#">2.5.4.2 [NB C-states]</a>                                                      |
| G1/S1: Stand By (Powered On Suspend)     | No        |                                                                                            |
| G1/S3: Stand By (Suspend to RAM)         | Yes       | <a href="#">2.5.8.1 [S-states]</a>                                                         |
| G1/S4: Hibernate (Suspend to Disk)       | Yes       |                                                                                            |
| G1/S5: Shut Down (Soft Off)              | Yes       |                                                                                            |
| G3 Mechanical Off                        | Yes       |                                                                                            |
| Parallel VID Interface                   | No        | <a href="#">2.5.1 [Processor Power Planes And Voltage Control]</a>                         |
| Serial VID Interface 1                   | No        |                                                                                            |
| Serial VID Interface 2                   | Yes       |                                                                                            |
| Single-plane systems                     | No        |                                                                                            |
| Number of voltage planes                 | 2         | <a href="#">2.5.1 [Processor Power Planes And Voltage Control]</a>                         |
| APM: Application Power Management        | Yes       | <a href="#">2.5.9 [Application Power Management (APM)]</a>                                 |

### 2.5.1 Processor Power Planes And Voltage Control

Refer to the *Electrical Data Sheet* for power plane definitions. See [1.2 \[Reference Documents\]](#).

#### 2.5.1.1 Serial VID Interface

The processor includes an interface to control external voltage regulators, called the serial VID interface (SVI). Only SVI2 is supported. The frequency of SVC for SVI2 is controlled by [D18F3xA0\[Svi2HighFreqSel\]](#). See the *AMD Serial VID Interface 2.0 (SVI2) Specification* for additional details.

##### 2.5.1.1.1 SVI2 Features

The processor supports the following SVI2 features:

- Voltage offsets:
  - VDD: [D18F5x12C](#)[CoreOffsetTrim].
  - VDDNB: [D18F5x188](#)[NbOffsetTrim].
- Load line trim:
  - VDD: [D18F5x12C](#)[CoreLoadLineTrim].
  - VDDNB: [D18F5x188](#)[NbLoadLineTrim].

### 2.5.1.2 Internal VID Registers and Encodings

All VID register fields within the processor are 8-bits wide. The VID encodings to voltage translation for all VID codes are defined by the SVI mode. See the *AMD Serial VID Interface 2.0 (SVI2) Specification* for additional details.

The boot VID is 1.0 volts.

#### 2.5.1.2.1 MinVid and MaxVid Check

Hardware limits the minimum and maximum VID code that is sent to the voltage regulator. The allowed limits are specified in [D18F5x17C](#)[MinVid, MaxVid]. Prior to generating VID-change commands to SVI, the processor filters the InputVid value to the OutputVid as follows (higher VID codes correspond to lower voltages and lower VID codes correspond to higher voltages):

- If InputVid < MaxVid, OutputVid=MaxVid.
  - Else if (InputVid > MinVid) & (MinVid!=00h), OutputVid=MinVid.
  - Else OutputVid=InputVid.

This filtering is applied regardless of the source of the VID-change command.

### 2.5.1.3 Low Power Features

#### 2.5.1.3.1 PSIX\_L Bit

The processor can indicate whether or not it's in a low-voltage state via the PSIX\_L bit. This indicator may be used by the voltage regulator to place itself into a more power efficient mode. PSIX\_L is controlled independently for VDD and VDDNB.

- The processor supports the PSIO\_L and the PSII\_L bits in the data fields of the SVI2 command.
  - PSIO\_L: PSIO\_L for VDD and VDDNB is enabled using [D18F3xA0](#)[PsiVidEn] and [D18F5x17C](#)[NbPsi0VidEn], respectively. Once enabled, the state of PSIO\_L is controlled by [D18F3xA0](#)[PsiVid[7:0]] and [D18F5x17C](#)[NbPsi0Vid]. Changes to the state of PSIO\_L can only occur on VID changes.
  - PSII\_L: The PSII\_L bit for VDD and VDDNB is specified by [D18F5x12C](#)[CorePsi1En] and [D0F0xBC\\_x3F9EC](#)[EnableNbPsi1], respectively. See also [D18F5x188](#)[NbPsi1]. Changes to the state of PSII\_L can occur at any time.

#### 2.5.1.3.1.1 BIOS Requirements for PSIO\_L

Enabling PSIO\_L for the VDD and VDDNB planes depends on support from the voltage regulator and is therefore system specific. The voltage regulator must be able to supply the current required for the processor to operate at the VID code specified in [D18F3xA0](#)[PsiVid[7:0]] and [D18F5x17C](#)[NbPsi0Vid[7:0]]. Depending on the regulator used, AMD recommends one of the following methods:

- PSIO\_L disabled:

- VDD: To set PSI0\_L for the VDD plane, program [D18F3xA0](#)[PsiVidEn]=0.
- VDDNB: To set PSI0\_L for the VDDNB plane, program [D18F5x17C](#)[NbPsi0VidEn]=0.
- PSI0\_L set/clear based on current requirements:
  - VDD: The following algorithm describes how to program PSI0\_L on VDD:

```

PSI_vrm_current = current at which the regulator allows PSI0_L.
previous_voltage = FFh

for (each P-state from P0 to D18F3xDC[HwPstateMaxVal]) {
    pstate_current = ProcIddMax for the current P-state,
                      see 2.5.3.1.7 \[Processor-Systemboard Power Delivery Compatibility Check\];
    pstate_voltage = MSRC001\_00[6B:64][CpuVid] of the current P-state;

    if (current P-state == D18F3xDC[HwPstateMaxVal]) {
        next_pstate_current = 0;
    } else {
        next_pstate_current = ProcIddMax for the next P-state,
                              see 2.5.3.1.7 \[Processor-Systemboard Power Delivery Compatibility Check\];
    }

    if ((pstate_current <= PSI_vrm_current) &&
        (next_pstate_current <= PSI_vrm_current) &&
        (pstate_voltage != previous_voltage)) {
        Program D18F3xA0[PsiVid] = pstate_voltage;
        Program D18F3xA0[PsiVidEn] = 1;
        break;
    }
    previous_voltage = pstate_voltage;
}

```

- VDDNB: The following algorithm describes how to program PSI0\_L on VDDNB:

NbIddMax = [D18F5x16](#)[C:0][NbIddDiv] current.

```

PSI_vrm_current = current at which the VDDNB regulator allows PSI0_L.
previous_voltage = FFh

for (each valid NB P-state starting with NBP0) {
    pstate_current = NbIddMax of the current NB P-state;
    pstate_voltage = D18F5x16[C:0][NbVid] of the current NB P-state;

    if (current P-state is the last valid P-state) {
        next_pstate_current = 0;
    } else {
        next_pstate_current = NbIddMax for the next P-state;
    }

    if ((pstate_current <= PSI_vrm_current) &&
        (next_pstate_current <= PSI_vrm_current) &&
        (pstate_voltage != previous_voltage)) {
        Program D18F5x17C[NbPsi0Vid] = pstate_voltage;
        Program D18F5x17C[NbPsi0VidEn] = 1;
        break;
    }
    previous_voltage = pstate_voltage;
}

```

### 2.5.1.3.2 Low Power Voltages

In order to save power, voltages lower than those normally needed for operation may be applied to the VDD power plane while the processor is in a C-state or S-state. The lower voltage is defined as follows:

- PC6Vid: [D18F5x128](#)[PC6Vid] specifies a voltage that does not retain the CPU caches or the core microarchitectural state. PC6Vid does not allow execution and is only applied to the cores. See [2.5.3.2.3.4 \[Package C6 \(PC6\) State\]](#).

### 2.5.1.4 Voltage Transitions

The processor supports dynamic voltage transitions on the VDD and VDDNB planes. These transitions are requested by either hardware or software during state changes such as reset, P-state changes, and C-state changes. In all cases the VID code passed to the voltage regulator changes from the old value to the new value without stepping through intermediate values. The voltage regulator ramps the voltage directly from the starting voltage to the final voltage, no stepping occurs. See the *AMD Serial VID Interface 2.0 (SVI2) Specification* for additional details.

- If a voltage increase is requested, the processor waits the amount of time specified by [D18F5x12C](#)[WaitVidCompDis] before sending any additional voltage change requests to the voltage regulator or before beginning a frequency transition.
- If a voltage decrease is requested, the processor waits the amount of time specified by [D18F5x128](#)[FastSlamTimeDown] before sending any additional voltage change requests to the voltage regulator. For voltage decreases, the processor does not wait any time before beginning frequency changes.

The processor continues code execution during voltage changes when in the C0 state.

#### 2.5.1.4.1 Hardware-Initiated Voltage Transitions

When software requests any of the following state changes, or hardware determines that any of the following state changes are necessary, hardware coordinates the necessary voltage changes:

- VDD:
  - Core P-state transition. See [2.5.3.1 \[Core P-states\]](#).
  - Package C-state transition. [D18F5x128](#)[PC6Vid] specifies a voltage that does not retain the CPU caches or the core microarchitectural state. PC6Vid does not allow execution and is only applied to the cores. See [2.5.3.2.3.4 \[Package C6 \(PC6\) State\]](#).
  - S-state transition. See [2.5.8.1 \[S-states\]](#).
- VDDNB:
  - NB P-state transition. See [2.5.4.1 \[NB P-states\]](#).
  - S-state transition. See [2.5.8.1 \[S-states\]](#).

#### 2.5.1.4.2 Software-Initiated Voltage Transitions

##### 2.5.1.4.2.1 Software-Initiated NB Voltage Transitions

Software can request voltage changes on the VDDNB power plane using the BIOSMC\_MSG\_VDDNB\_REQUEST software interrupt. To make a voltage change request, software uses the sequence described in [2.13.1 \[Software Interrupts\]](#) with Service Index 3Ah.

Software voltage requests are considered by hardware when taking voltage plane dependencies into account (see [2.5.2.2 \[Dependencies Between Subcomponents on VDDNB\]](#)).



## 2.5.2 Frequency and Voltage Domain Dependencies

### 2.5.2.1 Dependencies Between Cores

Whenever a P-state or C-state is requested on a core (see [2.5.3.1 \[Core P-states\]](#) and [2.5.3.2 \[Core C-states\]](#)), hardware must take the following frequency and voltage domain dependencies into account when deciding whether to make the requested change:

- Cores within a compute unit share a common frequency and voltage domain.
- Compute units within a processor share a common voltage domain, but have independent frequency domains. The voltage is determined by the highest-performance P-state requested on any core.

As a result, the P-state and C-state change requests have the following results:

- If different compute units request different voltages, the VDD voltage is determined by the highest voltage (lowest VID) requested.
- If the cores within a compute unit request different P-states while in C0, frequency and voltage are determined by the highest-performance P-state requested.
- If one core within a compute unit requests a CC6 while the other core is in C0, the frequency and voltage of the compute unit is determined by the core in C0.

### 2.5.2.2 Dependencies Between Subcomponents on VDDNB

Many subcomponents of the processor reside on the VDDNB power plane. Hardware must take voltage domain dependencies into account when determining whether to make a voltage change requested by one of the subcomponents. Whenever a state transition occurs that causes a voltage change request (see [2.5.1.4.1 \[Hardware-Initiated Voltage Transitions\]](#)), or software makes a voltage change request (see [2.5.1.4.2 \[Software-Initiated Voltage Transitions\]](#)), the VDDNB voltage requested by the processor is determined by the highest voltage (lowest VID) request made by any of the subcomponents or by software.

### 2.5.2.3 BIOS Requirements for Power Plane Initialization

- Ensure the following fields are configured to their BIOS recommendations:
  - [D18F3xA0\[Svi2HighFreqSel\]](#).
  - [D18F3xD8\[VSRampSlamTime\]](#).
- Optionally configure [PSIx\\_L](#). Refer to [2.5.1.3.1 \[PSIx\\_L Bit\]](#) for additional details.

## 2.5.3 CPU Power Management

### 2.5.3.1 Core P-states

Core P-states are operational performance states characterized by a unique combination of core frequency and voltage. The processor supports up to 8 core P-states (P0 through P7), specified in [MSRC001\\_00\[6B:64\]](#). Out of cold reset, the voltage and frequency of the compute units is specified by [MSRC001\\_0071\[StartupPstate\]](#).

Support for dynamic core P-state changes is indicated by more than one enabled selection in [MSRC001\\_00\[6B:64\]\[PstateEn\]](#). At least one enabled P-state (P0) is specified for all processors.

Software requests core P-state changes for each core independently using the hardware P-state control mechanism (a.k.a. fire and forget). Support for hardware P-state control is indicated by [CPUID Fn8000\\_0007\\_EDX\[HwPstate\]=1b](#). Software may not request any P-state transitions using the hardware P-state control mechanism until the P-state initialization requirements defined in [2.5.3.1.6 \[BIOS Requirements for Core P-state Initialization and Transitions\]](#) are complete.



The processor supports independently-controllable frequency planes for each compute unit and the NB; and independently-controllable voltage planes. See [2.5.1 \[Processor Power Planes And Voltage Control\]](#) for voltage plane definitions.

The following terms may be applied to each of these planes:

- FID: frequency ID. Specifies the PLL frequency multiplier, relative to the reference clock, for a given domain.
- DID: divisor ID. Specifies the post-PLL power-of-two divisor that can be used to reduce the operating frequency.
- COF: current operating frequency. Specifies the operating frequency as a function of the FID and DID. Refer to [CoreCOF](#) for the CPU COF formula and [NBCOF](#) for the NB COF formula.
- VID: voltage ID. Specifies the voltage level for a given domain. Refer to [2.5.1.2.1 \[MinVid and MaxVid Check\]](#) for encodings.

All FID and DID parameters for software P-states must be programmed to equivalent values for all cores and NBs in the coherent fabric. See [2.5.3.1.1.1 \[Software P-state Numbering\]](#). Refer to [MSRC001\\_00\[6B:64\]](#) and [D18F5x16\[C:0\]](#) for further details on programming requirements.

### 2.5.3.1.1 Core P-state Naming and Numbering

Since the number of boosted P-states may vary from product to product, the mapping between [MSRC001\\_00\[6B:64\]](#) and the indices used to request P-state changes or status also varies. In order to clarify this, two different numbering schemes are used.

#### 2.5.3.1.1.1 Software P-state Numbering

When referring to software P-state numbering, the following naming convention is used:

- Non-boosted P-states are referred to as P0, P1, etc.
  - P0 is the highest power, highest performance, non-boosted P-state.
  - Each ascending P-state number represents a lower-power, lower performance non-boosted P-state than the prior P-state number.
- Boosted P-states are referred to as Pb0, Pb1, etc.
  - Pb0 is the highest-performance, highest-power boosted P-state.
  - Each higher numbered boosted P-state represents a lower-power, lower-performance boosted P-state.

For example, if [D18F4x15C\[NumBoostStates\]](#) contains the values shown below, then the P-states would be named as follows:

**Table 10: Software P-state Naming**

| D18F4x15C[NumBoost-States]=1 |                           | D18F4x15C[NumBoost-States]=3 |                           |
|------------------------------|---------------------------|------------------------------|---------------------------|
| P-state Name                 | Corresponding MSR Address | P-state Name                 | Corresponding MSR Address |
| Pb0                          | MSRC001_0064              | Pb0                          | MSRC001_0064              |
| P0                           | MSRC001_0065              | Pb1                          | MSRC001_0065              |
| P1                           | MSRC001_0066              | Pb2                          | MSRC001_0066              |
| P2                           | MSRC001_0067              | P0                           | MSRC001_0067              |
| P3                           | MSRC001_0068              | P1                           | MSRC001_0068              |
| P4                           | MSRC001_0069              | P2                           | MSRC001_0069              |
| P5                           | MSRC001_006A              | P3                           | MSRC001_006A              |
| P6                           | MSRC001_006B              | P4                           | MSRC001_006B              |

All sections and register definitions use software P-state numbering unless otherwise specified.

#### 2.5.3.1.1.2 Hardware P-state Numbering

When referring to hardware P-state numbering, the following naming convention is used:

- All P-states are referred to as P0, P1, etc.
  - P0 is the highest power, highest-performance P-state, regardless of whether it is a boosted P-state or a non-boosted P-state.
  - Each ascending P-state number represents a lower-power, lower-performance P-state, regardless of whether it is a boosted P-state or not.

#### 2.5.3.1.2 Core P-state Control

Core P-states are dynamically controlled by software and are exposed through ACPI objects (refer to [2.5.3.1.8.3 \[ACPI Processor P-state Objects\]](#)). Software requests a core P-state change by writing a 3 bit index corresponding to the desired P-state number to [MSRC001\\_0062\[PstateCmd\]](#) of the appropriate core. For example, to request P3 for core 0 software would write 011b to core 0's [MSRC001\\_0062\[PstateCmd\]](#).

Boosted P-states may not be directly requested by software. Whenever software requests the P0 state on a processor that supports APM (i.e. writes 000b to [MSRC001\\_0062\[PstateCmd\]](#)), hardware dynamically places the core into the highest-performance P-state possible as determined by APM. See [2.5.9 \[Application Power Management \(APM\)\]](#).

Hardware sequences the frequency and voltage changes necessary to complete a P-state transition as specified by [2.5.3.1.5 \[Core P-state Transition Behavior\]](#) with no additional software interaction required. Hardware also coordinates frequency and voltage changes when differing P-state requests are made on cores that share a frequency or voltage plane. See [2.5.2 \[Frequency and Voltage Domain Dependencies\]](#) for details about hardware coordination.

**Table 11: Software P-state Control**

| D18F4x15C[NumBoostStates]=1 |                                |                           | D18F4x15C[NumBoostStates]=3 |                                |                           |
|-----------------------------|--------------------------------|---------------------------|-----------------------------|--------------------------------|---------------------------|
| P-state Name                | Index Used for Requests/Status | Corresponding MSR Address | P-state Name                | Index Used for Requests/Status | Corresponding MSR Address |
| Pb0                         | n/a                            | MSRC001_0064              | Pb0                         | n/a                            | MSRC001_0064              |
| P0                          | 0                              | MSRC001_0065              | Pb1                         | n/a                            | MSRC001_0065              |
| P1                          | 1                              | MSRC001_0066              | Pb2                         | n/a                            | MSRC001_0066              |
| P2                          | 2                              | MSRC001_0067              | P0                          | 0                              | MSRC001_0067              |
| P3                          | 3                              | MSRC001_0068              | P1                          | 1                              | MSRC001_0068              |
| P4                          | 4                              | MSRC001_0069              | P2                          | 2                              | MSRC001_0069              |
| P5                          | 5                              | MSRC001_006A              | P3                          | 3                              | MSRC001_006A              |
| P6                          | 6                              | MSRC001_006B              | P4                          | 4                              | MSRC001_006B              |

Hardware controls the VID for each voltage domain according to the highest requirement of the frequency domain(s) on each plane. For example, the VID for a 4 compute unit dual-plane system must be maintained at the highest level required for all 4 frequency domains. The number of frequency domains in a voltage domain is package/platform specific. Refer to 2.5.3.1.5 [Core P-state Transition Behavior] for details on hardware P-state voltage control. 2.5.2.3 [BIOS Requirements for Power Plane Initialization] specifies the processor initialization requirements for voltage plane control.

### 2.5.3.1.3 Core P-state Visibility

MSRC001\_0063[CurPstate] reflects the current non-boosted P-state number for each compute unit. For example, if MSRC001\_0063[CurPstate]=010b on compute unit 1, then compute unit 1 is in the P2 state. If a compute unit is in a boosted P-state, MSRC001\_0063[CurPstate] reads back as 0.

The voltage on a compute unit may not correspond to the VID code specified by the current P-state of the compute unit due to voltage plane dependencies. See 2.5.2 [Frequency and Voltage Domain Dependencies]. If a compute unit is in the P0 state (i.e. if MSRC001\_0063[CurPstate]=0), the frequency of the compute unit could be the frequency specified by P0 or any boosted P-state. To determine the frequency of a compute unit, see 2.5.3.3 [Effective Frequency].

### 2.5.3.1.4 Core P-state Limits

Core P-states may be limited to lower-performance values under certain conditions, including:

- HTC. See D18F3x64[HtcPstateLimit].
- Software. See D18F3x68[SwPstateLimit].
- Core Performance Boost. See 2.5.9 [Application Power Management (APM)].
- PROCHOT\_L assertion. See 2.10.3.1 [PROCHOT\_L and Hardware Thermal Control (HTC)].
- SMU. See D18F4x13C[SmuPstateLimit].

P-state limits are applied to all cores on the processor. The current P-state limit is provided in MSRC001\_0061[CurPstateLimit]. Changes to the MSRC001\_0061[CurPstateLimit] can be programmed to trigger interrupts through D18F3x64[PslApicLoEn, PslApicHiEn]. In addition, the maximum P-state value, regardless of the source, is limited as specified in MSRC001\_0061[PstateMaxVal].

### 2.5.3.1.5 Core P-state Transition Behavior

The following rules specify how P-states changes function and interact with other system or processor states:

- If the P-state number is increasing (the compute unit is moving to a lower-performance state), then the COF is changed first, followed by the VID change. If the P-state number is decreasing, then the VID is changed first followed by the COF.
- When the processor initiates a VID change that increases voltage for a voltage domain, no new voltage or frequency changes occur until [D18F3xD8\[VS RampSlamTime\]](#) has expired, regardless of whether any new requests are received. When the processor initiates a VID change that decreases voltage for a voltage domain, new voltage or frequency changes are allowed to occur immediately.
  - This is true regardless of whether the frequency or voltages changes occur as a result of P-state or C-state changes.
- If multiple commands are issued that affect the P-state of a domain prior to when the processor initiates the change of the P-state of that domain, then the processor operates on the last one issued.
- Once a P-state change starts, the P-state state machine (PSSM) continues through completion unless interrupted by a PWROK deassertion. If multiple P-state changes are requested concurrently, the PSSM may group the associated VID changes separately from the associated COF changes.
- Behavior during RESET\_L assertions:
  - All cores are transitioned to C0.
  - VDD VID is transitioned to HWP0 VID. See [MSRC001\\_0064\[CpuVid\]](#).
  - If there is no P-state transition activity, then the compute units and NB remain in the current P-state.
  - If a RESET\_L assertion interrupts a P-state transition, then the COF remains in it's current state at the time RESET\_L is asserted (either the value of the old or the new P-state). BIOS is required to transition to valid COF and VID settings after a warm reset according to the sequence defined in [2.5.3.1.8 \[BIOS COF and VID Requirements After Warm Reset\]](#).
  - After a warm reset [MSRC001\\_0063 \[P-state Status\]](#) is consistent with [MSRC001\\_0071\[CurPstate\]](#). [MSRC001\\_0062 \[P-state Control\]](#) may not be consistent with [MSRC001\\_0071\[CurPstate\]](#).
- The OS controls the P-state through [MSRC001\\_0062 \[P-state Control\]](#), independent of P-state limits described in [D18F3x64\[HtcPstateLimit\]](#), [D18F3x68\[SwPstateLimit\]](#). P-state limits interact with OS-directed P-state transitions as follows:
  - Of all the active P-state limits, the one that represents the lowest-performance P-state number, at any given time, is treated as an upper limit on performance.
  - As the limit becomes active or inactive, or if it changes, the P-state for each compute unit is placed in either the last OS-requested P-state or the new limit P-state, whichever is a lower performance P-state number.
    - If the resulting P-state number exceeds [MSRC001\\_0061\[PstateMaxVal\]](#), regardless of whether it is a limit or OS-requested, then the PstateMaxVal is used instead.

### 2.5.3.1.6 BIOS Requirements for Core P-state Initialization and Transitions

1. Check that [CPUID Fn8000\\_0007\\_EDX\[HwPstate\]](#)=1. If not, P-states are not supported, no P-state related ACPI objects should be generated, and BIOS must skip the rest of these steps.
2. Complete the [2.5.2.3 \[BIOS Requirements for Power Plane Initialization\]](#).
3. Ensure the following fields are configured to their BIOS recommendations:
  - [D18F3xA0\[PIILockTime\]](#).
  - [D18F3xD4\[PowerStepUp, PowerStepDown\]](#).
4. Transition all cores to the minimum performance P-state using the algorithm detailed in [2.5.3.1.8.2 \[Core Minimum P-state Transition Sequence After Warm Reset\]](#).
5. Complete the [2.5.4.1.3.1 \[NB P-state COF and VID Synchronization After Warm Reset\]](#). All cores on a processor must be in the minimum performance P-state prior to executing this sequence.

6. Complete the [2.5.3.1.7 \[Processor-Systemboard Power Delivery Compatibility Check\]](#).
7. Perform the following steps in any order:
  - A. Enable [2.5.9 \[Application Power Management \(APM\)\]](#) as follows:
    - Ensure the following fields are configured to their BIOS recommendations:
      - [D18F4x110\[CSampleTimer\]](#).
      - [D18F4x15C\[ApmMasterEn\]](#).
      - [D18F5xE0\[RunAvgRange\]](#).
    - See your AMD representative for details on how to enable the GPU aspects of [2.5.9 \[Application Power Management \(APM\)\]](#).
    - If [D18F4x15C\[NumBoostStates\] != 0](#), program [D18F4x15C\[BoostSrc\] = 1](#).
  - B. Transition all cores to the maximum performance P-state by writing 0 to [MSRC001\\_0062\[PstateCmd\]](#).
  - C. Create ACPI objects if necessary:
    - Determine the valid set of P-states as indicated by [MSRC001\\_00\[6B:64\]\[PstateEn\]](#).
    - If P-states are not supported, as indicated by only one enabled selection in [MSRC001\\_00\[6B:64\]\[PstateEn\]](#), then BIOS must not generate ACPI-defined P-state objects described in [2.5.3.1.8.3 \[ACPI Processor P-state Objects\]](#). Otherwise, the ACPI objects should be generated to enable P-state support.
  - D. Configure the COF and VID for each processor appropriately based on the sequence described in [2.5.4.1.3 \[BIOS NB P-state Configuration\]](#).
8. Configure [PSIx\\_L](#). Refer to [2.5.1.3.1 \[PSIx\\_L Bit\]](#) for additional details.

### 2.5.3.1.7 Processor-Systemboard Power Delivery Compatibility Check

BIOS must disable processor P-states that require higher power delivery than the systemboard can support. This power delivery compatibility check is designed to prevent system failures caused by exceeding the power delivery capability of the systemboard for the power plane(s) that contain the core(s). Refer to [2.5.1 \[Processor Power Planes And Voltage Control\]](#) for power plane definitions and configuration information. BIOS can optionally notify the user if P-states are detected that exceed the systemboard power delivery capability. Modifications to [MSRC001\\_00\[6B:64\]\[P-state \[7:0\]\]](#) must be applied equally to all cores on the same node. This check does not ensure functionality for all package/socket compatible processor/systemboard combinations.

[MSRC001\\_00\[6B:64\]\[PstateEn\]](#) must be set to 0 for any P-state MSR where [PstateEn=1](#) and the processor current requirement ([ProcIddMax](#)), defined by the following equation, is greater than the systemboard current delivery capability.

$$\text{ProcIddMax} = \text{MSRC001\_00[6B:64][IddValue]} \text{ current} * 1/10^{\text{MSRC001\_00[6B:64][IddDiv]}} * (\text{D18F5x84[CmpCap]}+1)$$

The power delivery check should be applied starting with hardware P0 and continue with increasing P-state indexes (1, 2, 3, and 4) for all enabled P-states. Once a compatible P-state is found using the [ProcIddMax](#) equation the check is complete. All processor P-states with higher indexes are defined to be lower power and performance, and are therefore compatible with the systemboard.

Example:

- [MSRC001\\_0065\[IddValue\]](#) = 32d
- [MSRC001\\_0065\[IddDiv\]](#) = 0d
- [D18F5x84\[CmpCap\]](#) = 1d
- [ProcIddMax](#) = 32 \* 1 \* 2 = 64A per plane

The systemboard must be able to supply  $\geq 64\text{A}$  for the unified core power plane in order to support P1 for this

processor. If the systemboard current delivery capability is < 64A per plane then BIOS must set `MSRC001_0065[PstateEn]=0` for all cores on this node, and continue by checking P2 in the same fashion.

If no P-states are disabled while performing the power delivery compatibility check then BIOS does not need to take any action.

If at least one P-state is disabled by performing the power delivery compatibility check and at least one P-state remains enabled, then BIOS must perform the following steps:

1. If the P-state pointed to by `MSRC001_0063[CurPstate]` is disabled by the power delivery compatibility check, then BIOS must request a transition to an enabled P-state using `MSRC001_0062[PstateCmd]` and wait for `MSRC001_0063[CurPstate]` to reflect the new value.
2. Copy the contents of the enabled P-state MSR (`MSRC001_00[6B:64]`) to the highest performance P-state locations. E.g. if P0 and P1 are disabled by the power delivery compatibility check and P2 - P4 remain enabled, then the contents of P2 - P4 should be copied to P0 - P2 and P3 and P4 should be disabled (`PstateEn=0`). This step uses software P-state numbering. See 2.5.3.1.1.1 [Software P-state Numbering].
3. Request a P-state transition to the P-state MSR containing the COF/VID values currently applied. E.g. If `MSRC001_0063[CurPstate]=100b` and P4 P-state MSR information is copied to P2 in step 2, then BIOS should write 010b to `MSRC001_0062[PstateCmd]` and wait for `MSRC001_0063[CurPstate]` to reflect the new value.
4. If a subset of boosted P-states are disabled, then copy the contents of the P-state MSR pointed to by the highest performance boosted P-state that is enabled to the P-state MSRs pointed to by the boosted P-states that are disabled.
5. If all boosted P-states are disabled, then program `D18F4x15C[BoostSrc]=0`.
6. Adjust the following P-state parameters affected by the P-state MSR copy by subtracting the number of software P-states that are disabled by the power delivery compatibility check. This calculation should not wrap, but saturate at 0. E.g. if P0 and P1 are disabled, then each of the following register fields should have 2 subtracted from them:
  - `D18F3x64[HtcPstateLimit]`
  - `D18F3x68[SwPstateLimit]`
  - `D18F3xDC[HwPstateMaxVal]`

If any node has all P-states disabled after performing the power delivery compatibility check, then BIOS must perform the following steps. This does not ensure operation and BIOS should notify the user of the incompatibility between the processor and systemboard if possible.

1. If `MSRC001_0063[CurPstate] != MSRC001_0061[PstateMaxVal]`, then write `MSRC001_0061[PstateMaxVal]` to `MSRC001_0062[PstateCmd]` and wait for `MSRC001_0063[CurPstate]` to reflect the new value.
2. If `MSRC001_0061[PstateMaxVal] != 000b` copy the contents of the P-state MSR pointed to by `MSRC001_0061[PstateMaxVal]` to `MSRC001_0064` and set `MSRC001_0064[PstateEn]`; Write 000b to `MSRC001_0062[PstateCmd]` and wait for `MSRC001_0063[CurPstate]` to reflect the new value. This step uses software P-state numbering. See 2.5.3.1.1.1 [Software P-state Numbering].
3. Adjust the following fields to 000b.
  - `D18F3x64[HtcPstateLimit]`
  - `D18F3x68[SwPstateLimit]`
  - `D18F3xDC[HwPstateMaxVal]`
4. Program `D18F4x15C[BoostSrc]=0`.

### 2.5.3.1.8 BIOS COF and VID Requirements After Warm Reset

Warm reset is asynchronous and can interrupt P-state transitions leaving the processor in a VID state that does not correspond to `MSRC001_0063[CurPstate]` on any core. The processor frequency after warm reset



corresponds to [MSRC001\\_0063\[CurPstate\]](#). See [2.5.3.1.5 \[Core P-state Transition Behavior\]](#) for P-state transition behavior when RESET\_L is asserted. BIOS is required to transition the processor to valid COF and VID settings corresponding to an enabled P-state following warm reset. The cores may be transitioned to either the maximum or minimum P-state COF and VID settings using the sequences defined in [2.5.3.1.8.1 \[Core Maximum P-state Transition Sequence After Warm Reset\]](#) and [2.5.3.1.8.2 \[Core Minimum P-state Transition Sequence After Warm Reset\]](#). Transitioning to the minimum P-state after warm reset is recommended to prevent undesired system behavior if a warm reset occurs before the [2.5.3.1.7 \[Processor-Systemboard Power Delivery Compatibility Check\]](#) is complete. BIOS is not required to manipulate NB COF and VID settings following warm reset if the warm reset was issued by BIOS to update [D18F5x16\[C:0\]\[NbFid\[5:0\]\]](#).

#### 2.5.3.1.8.1 Core Maximum P-state Transition Sequence After Warm Reset

1. If [MSRC001\\_0071\[CurPstate\]](#) = [D18F3xDC\[HwPstateMaxVal\]](#), then skip step 3 for that core.
2. Write [MSRC001\\_0061\[PstateMaxVal\]](#) to [MSRC001\\_0062\[PstateCmd\]](#) on all cores in the processor.
3. Wait for [MSRC001\\_0071\[CurCpuFid, CurCpuDid\]](#) = [CpuFid[5:0], CpuDid] from [MSRC001\\_00\[6B:64\]](#) indexed by [D18F3xDC\[HwPstateMaxVal\]](#).
4. Wait for [MSRC001\\_0071\[CurCpuVid\]](#) = [CurCpuVid] from [MSRC001\\_00\[6B:64\]](#) indexed by [D18F3xDC\[HwPstateMaxVal\]](#).
5. All previous steps must be completed on all cores prior to continuing the sequence since a compute unit transitions to the highest performance P-state requested on either core.
6. Write 0 to [MSRC001\\_0062\[PstateCmd\]](#) on all cores in the processor.
7. Wait for [MSRC001\\_0071\[CurCpuFid, CurCpuDid\]](#) = [CpuFid[5:0], CpuDid] from [MSRC001\\_00\[6B:64\]](#) indexed by [MSRC001\\_0071\[CurPstateLimit\]](#).
8. If [MSRC001\\_0071\[CurPstateLimit\]](#) != [D18F3xDC\[HwPstateMaxVal\]](#), wait for [MSRC001\\_0071\[CurCpuVid\]](#) = [CpuVid] from [MSRC001\\_00\[6B:64\]](#) indexed by [MSRC001\\_0071\[CurPstateLimit\]](#).
9. Wait for [MSRC001\\_0063\[CurPstate\]](#) = [MSRC001\\_0061\[CurPstateLimit\]](#).

#### 2.5.3.1.8.2 Core Minimum P-state Transition Sequence After Warm Reset

1. If [MSRC001\\_0071\[CurPstate\]](#) = [MSRC001\\_0071\[CurPstateLimit\]](#), then skip step 3 for that core.
2. Write 0 to [MSRC001\\_0062\[PstateCmd\]](#) on all cores in the processor.
3. Wait for [MSRC001\\_0071\[CurCpuFid, CurCpuDid\]](#) = [CpuFid[5:0], CpuDid] from [MSRC001\\_00\[6B:64\]](#) indexed by [MSRC001\\_0071\[CurPstateLimit\]](#).
4. Write [MSRC001\\_0061\[PstateMaxVal\]](#) to [MSRC001\\_0062\[PstateCmd\]](#) on all cores in the processor.
5. Wait for [MSRC001\\_0071\[CurCpuFid, CurCpuDid\]](#) = [CpuFid[5:0], CpuDid] from [MSRC001\\_00\[6B:64\]](#) indexed by [D18F3xDC\[HwPstateMaxVal\]](#).
6. If [MSRC001\\_0071\[CurPstateLimit\]](#) != [MSRC001\\_0071\[CurPstate\]](#), wait for [MSRC001\\_0071\[CurCpuVid\]](#) = [CpuVid] from [MSRC001\\_00\[6B:64\]](#) indexed by [D18F3xDC\[HwPstateMaxVal\]](#).
7. Wait for [MSRC001\\_0063\[CurPstate\]](#) = [MSRC001\\_0062\[PstateCmd\]](#).

#### 2.5.3.1.8.3 ACPI Processor P-state Objects

Processor performance control is implemented through the \_PCT, \_PSS and \_PSD objects in ACPI 2.0 and later revisions. The presence of these objects indicates to the OS that the platform and processor are capable of supporting multiple performance states. Processor performance states are not supported with ACPI 1.0b. BIOS must provide the \_PCT, \_PSS, and \_PSD objects, and define other ACPI parameters to support operating systems that provide native support for processor P-state transitions.

The following rules apply to BIOS generated ACPI objects in multi-core systems. Refer to the appropriate

ACPI specification for additional details:

- All cores must expose the same number of performance states to the OS.
- The respective performance states displayed to the OS for each core must have identical performance and power-consumption parameters (e.g. P0 on core 0 must have the same performance and power-consumptions parameters as P0 on core 1, P1 on core 0 must have the same parameters as P1 on core 1, however P0 can be different than P1).
- Performance state objects must be present under each processor object in the system.

#### 2.5.3.1.8.3.1 **\_PCT (Performance Control)**

BIOS must declare the performance control object parameters as functional fixed hardware. This definition indicates the processor driver understands the architectural definition of the P-state interface associated with [CPUID Fn8000\\_0007\\_EDX\[HwPstate\]=1](#).

- Perf\_Ctrl\_Register = Functional Fixed Hardware
- Perf\_Status\_Register = Functional Fixed Hardware

#### 2.5.3.1.8.3.2 **\_PSS (Performance Supported States)**

A unique **\_PSS** entry is created for each non-boosted P-state. The value contained in the **\_PSS Control** field is written to [MSRC001\\_0062 \[P-state Control\]](#) to request a P-state change to the CoreFreq of the associated **\_PSS** object. The value contained in [MSRC001\\_0063 \[P-state Status\]](#) can be used to identify the **\_PSS** object of the current P-state request by equating [MSRC001\\_0063\[CurPstate\]](#) to the value of the Status field. See [2.5.3.1 \[Core P-states\]](#).

BIOS loops through each of [MSRC001\\_00\[6B:64\]](#) applying the following formulas to create the fields for the **\_PSS** object for for each valid P-state (see [MSRC001\\_00\[6B:64\]\[PstateEn\]](#)). BIOS skips over any P-state MSRs that specify boost P-states (see [D18F4x15C\[NumBoostStates\]](#)).

- CoreFreq (MHz) = Calculated using the formula for [CoreCOF](#).
- Power (mW) = [MSRC001\\_00\[6B:64\]\[CpuVid\]](#) voltage \* [MSRC001\\_00\[6B:64\]\[IddValue\]](#) current \* 1000.
- TransitionLatency (us) and BusMasterLatency (us):
  - If [MSRC001\\_00\[6B:64\]\[CpuFid\[5:0\]\]](#) is the same for all enabled P-states (see [MSRC001\\_00\[6B:64\]\[PstateEn\]](#)) and all boosted P-states:
    - TransitionLatency = BusMasterLatency = (15 steps \* [D18F3xD4\[PowerStepDown\]](#) time \* 1000 us/ns) + (15 steps \* [D18F3xD4\[PowerStepUp\]](#) time \* 1000 us/ns)
  - Else if [MSRC001\\_00\[6B:64\]\[CpuFid\[5:0\]\]](#) is different for any enabled (see [MSRC001\\_00\[6B:64\]\[PstateEn\]](#)) or boost P-states:
    - TransitionLatency = BusMasterLatency = (15 steps \* [D18F3xD4\[PowerStepDown\]](#) time \* 1000 us/ns) + [D18F3xA0\[PllLockTime\]](#) time + (15 steps \* [D18F3xD4\[PowerStepUp\]](#) time \* 1000 us/ns)
  - Example:
    - [MSRC001\\_00\[6B:64\]\[CpuFid\[5:0\]\]](#) is not the same for all P-states
    - [D18F3xD4\[PowerStepDown\]](#) = [D18F3xD4\[PowerStepUp\]](#) = 8h (50 ns/step)
    - [D18F3xA0\[PllLockTime\]](#) = 001b (2 us)
    - TransitionLatency = BusMasterLatency = (15 steps \* 50 ns/step / 1000 us/ns) + 2us + (15 steps \* 50 ns/step / 1000 us/ns) = 3.5 us (round up to 4 us)
- Control/Status:
  - The highest performance non-boosted P-state must have the **\_PSS control** and status fields programmed to 0.
  - Any lower performance non-boosted P-states must have the **\_PSS control** and status fields programmed



in ascending order.

#### 2.5.3.1.8.3.3 **\_PPC (Performance Present Capabilities)**

The **\_PPC** object is optional. Refer to the ACPI specification for details on use and content.

#### 2.5.3.1.8.3.4 **\_PSD (P-state Dependency)**

AMD recommends the ACPI 3.0 **\_PSD** object be generated for each core as follows to cause the cores to transition between P-states independently:

- NumberOfEntries = 5.
- Revision = 0.
- Domain = CPUID Fn0000\_0001\_EBX[LocalApicId[7:2]].
- CoordType = FEh. (HW\_ALL)
- NumProcessors = 2.

A vendor may choose to generate **\_PSD** object to allow cores to transition between P-states together as follows:

- NumberOfEntries = 5.
- Revision = 0.
- Domain = 0.
- CoordType = FCh. (SW\_ALL)
- NumProcessors = CPUID Fn8000\_0008\_ECX[NC] + 1.

BIOS provides an option to choose between either **\_PSD** definition.

#### 2.5.3.1.8.4 **Fixed ACPI Description Table (FADT) Entries**

Declare the following FADT entries:

- PSTATE\_CNT = 00h.
- DUTY\_WIDTH = 00h.

#### 2.5.3.1.8.5 **XPSS (Microsoft® Extended PSS) Object**

Some Microsoft® operating systems require an XPSS object to make P-state changes function properly. A BIOS that implements an XPSS object has special requirements for the **\_PCT** object. See the Microsoft® *Extended PSS ACPI Method Specification* for the detailed requirements to implement these objects.

### 2.5.3.2 **Core C-states**

C-states are processor power states. C0 is the operational state in which instructions are executed. All other C-states are low-power states in which instructions are not executed. When coming out of warm and cold reset, the processor is transitioned to the C0 state.

#### 2.5.3.2.1 **C-state Names and Numbers**

C-states are often referred to by an alphanumeric naming convention, C1, C2, C3, etc. The mapping between ACPI defined C-states and AMD specified C-states is not direct. AMD specified C-states are referred to as IO-based C-states. Up to three IO-based C-states are supported, IO-based C-state 0, 1, and 2. The IO-based C-state index corresponds to the offset added to **MSRC001\_0073**[CstateAddr] to initiate a C-state request. See [2.5.3.2.2 \[C-state Request Interface\]](#). The actions taken by the processor when entering a low-power C-state are configured by software. See [2.5.3.2.3 \[C-state Actions\]](#) for information about AMD specific actions.

### 2.5.3.2.2 C-state Request Interface

C-states are dynamically requested by software and are exposed through ACPI objects (see [2.5.3.2.6 \[ACPI Processor C-state Objects\]](#)). C-states can be requested on a per-core basis. Software requests a C-state change in one of two ways:

- Reading from an IO address: The IO address must be the address specified by [MSRC001\\_0073](#)[CstateAddr] plus an offset of 0 through 7. The processor always returns 0 for this IO read. Offsets 2 through 7 result in an offset of 2.
- Executing the HLT instruction. This is equivalent to reading from the IO address specified by [D18F4x128](#)[HaltCstateIndex].

When software requests a C-state transition, hardware evaluates any frequency and voltage domain dependencies and determines which C-state actions to execute. See [2.5.2 \[Frequency and Voltage Domain Dependencies\]](#) and [2.5.3.2.3 \[C-state Actions\]](#).

### 2.5.3.2.3 C-state Actions

A core takes one of several different possible actions based upon a C-state change request from software. The C-state action fields are defined in [D18F4x11](#)[C:8].

#### 2.5.3.2.3.1 C-state Probes and Cache Flushing

If probes occur after a core enters a non-C0 state, and the caches are not flushed by hardware, the core clock may be ramped back up to the C0 frequency to service the probes, as specified by [D18F4x118/D18F4x11C](#)[CpuPrbEn].

If a core enters a non-C0 state and cache flush is enabled (see [D18F3xDC](#)[CacheFlushOnHaltCtl] and [D18F4x118/D18F4x11C](#)[CacheFlushEn]), a timer counts down for a programmable period of time as specified by [D18F3xDC](#)[CacheFlushOnHaltTmr] or [D18F4x118/D18F4x11C](#)[CacheFlushTmrSel]. When the timer expires, the core flushes its L1 and L2 caches to DRAM and the core clocks are ramped down to a divisor specified by [D18F3xDC](#)[CacheFlushOnHaltCtl]. The timer is reset if the core exits the C-state for any reason. See [2.5.3.2.4.2 \[Cache Flush On Halt Saturation Counter\]](#).

Once a core flushes its caches, probes are no longer sent to that core. This improves probing performance for cores that are in C0.

#### 2.5.3.2.3.2 Core C1 (CC1) State

When a core enters the CC1 state, its clock ramps down to the frequency specified by [D18F4x118/D18F4x11C](#)[ClkDivisorCstAct].

#### 2.5.3.2.3.3 Core C6 (CC6) State

A core can gate off power to its internal logic when it enters any non-C0 state. This power gated state is known as CC6. In order to enter CC6, hardware first enters CC1 and then flushes the caches (see [2.5.3.2.3.1 \[C-state Probes and Cache Flushing\]](#)) before checking [D18F4x118/D18F4x11C](#)[PwrGateEnCstAct]. Power gating reduces the amount of power consumed by the core. VDD voltage is not reduced when a core is in CC6. The following sequence occurs when a core enters the CC6 state:

1. If [MSRC001\\_0071](#)[CurPstate] < [D18F3xA8](#)[PopDownPstate], transition the core P-state to [D18F3xA8](#)[PopDownPstate].
2. L1 and L2 caches are flushed to DRAM. See [2.5.3.2.3.1 \[C-state Probes and Cache Flushing\]](#).
3. Internal core state is saved to DRAM.

- Power is removed from the core and the core PLL/voltage regulator is powered down as specified by [D18F5x128\[CC6PwrDwnRegEn\]](#).

All of the following must be true in order for a core to be placed into CC6:

- [D18F4x118/D18F4x11C\[CacheFlushEn\]](#)=1 for the corresponding C-state action field.
- [D18F4x118/D18F4x11C\[CacheFlushTmrSel\]](#) != 11b for the corresponding C-state action field.
- [D18F4x118/D18F4x11C\[PwrGateEnCstAct\]](#)=1 for the corresponding C-state action field.
- [D18F2x118\[CC6SaveEn\]](#)=1.
- [D18F2x118\[LockDramCfg\]](#)=1.
- The CC6 storage area in DRAM is configured. See [2.9.13 \[DRAM CC6/PC6 Storage\]](#).

The events which cause a core to exit the CC6 state are specified in [2.5.3.2.5 \[Exiting C-states\]](#).

If a warm reset occurs while a core is in CC6, all MCA registers in the core shown in [Table 47](#) are cleared to 0. See [2.15.1 \[Machine Check Architecture\]](#).

The time required to enter and exit CC6 is directly proportional to the core P-state frequency. Slower core frequencies require longer entry and exit times. Latency issues may occur with core P-state frequencies less than 800MHz.

#### 2.5.3.2.3.4 Package C6 (PC6) State

When all cores enter a non-C0 state, VDD can be reduced to a non-operational voltage that does not retain core state. This state is known as PC6 and reduces the amount of static and dynamic power consumed by all cores.

The following actions are taken by hardware prior to PC6 entry:

- If [MSRC001\\_0071\[CurPstate\]](#) < [D18F3xA8\[PopDownPstate\]](#), transition the core P-state to [D18F3xA8\[PopDownPstate\]](#).
- For all cores not in CC6, L1 and L2 caches are flushed to DRAM. See [2.5.3.2.3.1 \[C-state Probes and Cache Flushing\]](#).
- For all cores not in CC6, internal core state is saved to DRAM.
- VDD is transitioned to the VID specified by [D18F5x128\[PC6Vid\]](#).
- If the core PLLs are not powered down during CC6 entry (see [2.5.3.2.3.3 \[Core C6 \(CC6\) State\]](#)), then they are powered down as specified by [D18F5x128\[PC6PwrDwnRegEn\]](#).

All of the following must be true on all cores in order for a package to be placed into PC6:

- [D18F4x118/D18F4x11C\[CacheFlushEn\]](#)=1 for the corresponding C-state action field
- [D18F4x118/D18F4x11C\[CacheFlushTmrSel\]](#) != 11b for the corresponding C-state action field.
- [D18F4x118/D18F4x11C\[PwrOffEnCstAct\]](#)=1 for the corresponding C-state action field.
- [D18F2x118\[CC6SaveEn\]](#)=1.
- [D18F2x118\[LockDramCfg\]](#)=1.
- [MSRC001\\_0015\[HltXSpCycEn\]](#)=1.

#### 2.5.3.2.4 C-state Request Monitors

Deeper C-states have higher entry and exit latencies but provide greater power savings than shallower C-states. To help balance the performance and power needs of the system, the processor can limit access to specific C-states in certain scenarios.

##### 2.5.3.2.4.1 FCH Messaging

The FCH can be notified when the processor transitions package C-states. See the following:

- [D18F4x128](#)[CstateMsgDis].
- [D18F5x178](#)[CstateFusionDis].
- [MSRC001\\_0015](#)[HltXSpCycEn].

#### 2.5.3.2.4.2 Cache Flush On Halt Saturation Counter

A cache flush success monitor tracks the success rate of cache flush timer expirations relative to the core exiting a C-state. Based on the success rate, caches may be flushed immediately without waiting for the cache flush timer to expire. See [D18F4x128](#)[CacheFlushSucMonThreshold]. When the core resumes normal execution, the caches refill as normal.

#### 2.5.3.2.5 Exiting C-states

The following events may cause the processor to exit a non-C0 C-state and return to C0:

- INTR
- NMI
- SMI
- INIT
- RESET\_L assertion

If an INTR is received while a core is in a non-C0 C-state, the state of EFLAGS[IF] and the mechanism used to enter the non-C0 C-state determine the actions taken by the processor.

- Entry via HLT, EFLAGS[IF]==0: The interrupt does not wake up the core.
- Entry via HLT, EFLAGS[IF]==1: The interrupt wakes the core and the core begins execution at the interrupt service routine.
- Entry via IO read, EFLAGS[IF]==0: The interrupt wakes the core and the core begins execution at the instruction after the IN instruction that was used to enter the non-C0 C-state.
- Entry via IO read, EFLAGS[IF]==1: The interrupt wakes the core and the core begins execution at the interrupt service routine.

#### 2.5.3.2.6 ACPI Processor C-state Objects

Processor power control is implemented through the `_CST` object in ACPI 2.0 and later revisions. The presence of the `_CST` object indicates to the OS that the platform and processor are capable of supporting multiple power states. BIOS must provide the `_CST` object and define other ACPI parameters to support operating systems that provide native support for processor C-state transitions. See [2.5.3.2.6.1 \[\\_CST\]](#). See [2.5.3.2.6.2 \[\\_CSD\]](#).

The `_CST` object is not supported with ACPI 1.0b. BIOS should provide FADT entries to support operating systems that are not compatible with ACPI 2.0 and later revisions. See [2.5.3.2.6.3 \[\\_CRS\]](#).

##### 2.5.3.2.6.1 `_CST`

The `_CST` object should be generated for each core as follows:

- Count = 1.
- Register = [MSRC001\\_0073](#)[CstateAddr] + 1.
- Type = 2.
- Latency = 400.
- Power = 0.

### 2.5.3.2.6.2     \_CSD

The \_CSD object should be generated for each core as follows:

- NumberOfEntries = 6.
- Revision = 0.
- Domain = [CPUID Fn0000\\_0001\\_EBX](#)[LocalApicId[7:1]].
- CoordType = FEh. (HW\_ALL)
- NumProcessors = 2.
- Index = 0.

### 2.5.3.2.6.3     \_CRS

BIOS must declare in the root host bridge \_CRS object that the IO address range from [MSRC001\\_0073](#)[CstateAddr] to [MSRC001\\_0073](#)[CstateAddr]+7 is consumed by the host bridge.

### 2.5.3.2.6.4     Fixed ACPI Description Table (FADT) Entries

Declare the following FADT entries:

- P\_LVL2\_LAT = 100.
- P\_LVL3\_LAT = 1001.
- FLAGS.PROC\_C1 = 1.
- FLAGS.P\_LVL2\_UP = 1.

Declare the following P\_BLK entries:

- P\_LVL2 = [MSRC001\\_0073](#)[CstateAddr] + 1.
- P\_LVL3 = 0.

BIOS must declare the PSTATE\_CNT entry as 00h.

### 2.5.3.2.7     BIOS Requirements for Initialization

1. Initialize [MSRC001\\_0073](#)[CstateAddr] with an available IO address. See 2.5.3.2.6.3 [\_CRS].
2. Initialize [D18F4x11](#)[C:8].
3. Generate ACPI objects as described in 2.5.3.2.6 [ACPI Processor C-state Objects].

### 2.5.3.3     Effective Frequency

The effective frequency interface allows software to discern the average, or effective, frequency of a given core over a configurable window of time. This provides software a measure of actual performance rather than forcing software to assume the current frequency of the core is the frequency of the last P-state requested. This can be useful when the P-state is limited by:

- HTC
- [D18F3x68](#)[SwPstateLimit]
- SBI
- CPB

The following procedure calculates effective frequency using [MSR0000\\_00E7](#) [Max Performance Frequency Clock Count (MPERF)] and [MSR0000\\_00E8](#) [Actual Performance Frequency Clock Count (APERF)]:

1. At some point in time, write 0 to both MSRs.
2. At some later point in time, read both MSRs.
3. Effective frequency = (value read from [MSR0000\\_00E8](#) / value read from [MSR0000\\_00E7](#)) \* P0 fre-

quency using software P-state numbering.

Additional notes:

- The amount of time that elapses between steps 1 and 2 is determined by software.
- It is software's responsibility to disable interrupts or any other events that may occur in between the write of [MSR0000\\_00E7](#) and the write of [MSR0000\\_00E8](#) in step 1 or between the read of [MSR0000\\_00E7](#) and the read of [MSR0000\\_00E8](#) in step 2.
- The behavior of [MSR0000\\_00E7](#) and [MSR0000\\_00E8](#) may be modified by [MSRC001\\_0015](#)[EffFreqCntMwait].
- The effective frequency interface provides +/- 50MHz accuracy if the following constraints are met:
- Effective frequency is read at most one time per millisecond.
- When reading or writing [MSR0000\\_00E7](#) and [MSR0000\\_00E8](#) software executes only MOV instructions, and no more than 3 MOV instructions, between the two RDMSR or WRMSR instructions.
- [MSR0000\\_00E7](#) and [MSR0000\\_00E8](#) are invalid if an overflow occurs.

## 2.5.4 NB Power Management

### 2.5.4.1 NB P-states

The processor supports up to four NB P-states (NBP0 through NBP3), specified in [D18F5x16\[C:0\]](#). Each NB P-state consists of the following:

- Enable: [D18F5x16\[C:0\]\[NbPstateEn\]](#).
- NCLK frequency: [D18F5x16\[C:0\]\[NbFid\[5:0\], NbDid\]](#).
- VDDNB voltage: [D18F5x16\[C:0\]\[NbVid\]](#).
- Memory P-state: [D18F5x16\[C:0\]\[MemPstate\]](#). See 2.5.7.1 [Memory P-states].

Out of cold reset, the NB P-state is specified by [D18F5x174\[StartupNbPstate\]](#) and [D18F3xA0\[CofVidProg\]](#). The current NB P-state is specified by [D18F5x174\[CurNbFid\[5:0\], CurNbDid, {CurNbVid\[7\], CurNbVid\[6:0\]\]\]](#).

Although four NB P-states are defined, only two NB P-states are used at any given time, specified by [D18F5x170\[NbPstateHi, NbPstateLo\]](#).

#### 2.5.4.1.1 Northbridge Dynamic Power Management (NB DPM)

Northbridge Dynamic Power Management (NB DPM) dynamically changes which two of the four NB P-states are in use based on GPU activity as follows:

- When the GPU is active :
  - The high NB P-state is specified by [D0F0xBC\\_x3F9E8\[DpmXNbPsHi\]](#).
  - The low NB P-state is specified by [D0F0xBC\\_x3F9E8\[DpmXNbPsLo\]](#).
- When the GPU is idle and the timer specified by [D0F0xBC\\_x3F9EC\[Hysteresis\]](#) has expired:
  - The high NB P-state is specified by [D0F0xBC\\_x3F9E8\[Dpm0PgNbPsHi\]](#).
  - The low NB P-state is specified by [D0F0xBC\\_x3F9E8\[Dpm0PgNbPsLo\]](#).

In addition, hardware forces the NB P-state to the active high or low NB P-state based on the GPU activity level.

#### 2.5.4.1.2 NB P-state Transitions

Hardware selects whether to use the high or low NB P-state based on several criteria as follows:

- Core P-state:
  - [MSRC001\\_00\[6B:64\]](#)[NbPstate].
  - [D18F5x170](#)[NbPstateThreshold].
- GPU activity:
  - The GPU driver selects levels of GPU activity that force the NB P-state to either the high or low state or allow either NB P-state.
- Hysteresis timer:
  - [D18F5x170](#)[NbPstateHiRes, NbPstateLoRes].
- The following configuration registers:
  - [D18F5x170](#)[SwNbPstateLoDis, NbPstateDisOnP0].
  - [MSRC001\\_0071](#)[NbPstateDis].

Once the NB determines that an NB P-state transition is necessary, the NB executes the following sequence:

1. If transitioning from the low NB P-state to the high NB P-state, transition VDDNB voltage.
2. If the GPU is enabled as specified by [D18F5x178](#)[SwGfxDis], wait for display buffer to fill.
3. Quiesce all active cores.
4. If the internal GPU is enabled as specified by [D18F5x178](#)[SwGfxDis], wait for display buffer to fill.
5. Stop memory traffic and place DRAM into self-refresh.
6. Transition NCLK frequency.
7. Update NB P-state specific DRAM settings within hardware, see [D18F2x210\\_dct\[3:0\]\\_nbp\[3:0\]](#).
8. Take DRAM out of self-refresh and allow memory traffic.
9. Wake up cores.
10. If transitioning from the high NB P-state to the low NB P-state, transition VDDNB voltage.

### 2.5.4.1.3 BIOS NB P-state Configuration

#### 2.5.4.1.3.1 NB P-state COF and VID Synchronization After Warm Reset

BIOS performs the following sequence on one core. This is done after any warm reset and before [2.9.9 \[DCT/DRAM Initialization and Resume\]](#).

1. Temp1=[D18F5x170](#)[SwNbPstateLoDis].
2. Temp2=[D18F5x170](#)[NbPstateDisOnP0].
3. Temp3=[D18F5x170](#)[NbPstateThreshold].
4. Temp4=[D18F5x170](#)[NbPstateGnbSlowDis].
5. If [MSRC001\\_0070](#)[NbPstate]=0, go to step 6. If [MSRC001\\_0070](#)[NbPstate]=1, go to step 11.
6. Write 1 to [D18F5x170](#)[NbPstateGnbSlowDis].
7. Write 0 to [D18F5x170](#)[SwNbPstateLoDis, NbPstateDisOnP0, NbPstateThreshold].
8. Wait for [D18F5x174](#)[CurNbPstate] = [D18F5x170](#)[NbPstateLo] and [D18F5x174](#)[CurNbFid[5:0], CurNbDid]=[NbFid[5:0], NbDid] from [D18F5x16\[C:0\]](#) indexed by [D18F5x170](#)[NbPstateLo].
9. Set [D18F5x170](#)[SwNbPstateLoDis]=1.
10. Wait for [D18F5x174](#)[CurNbPstate] = [D18F5x170](#)[NbPstateHi] and [D18F5x174](#)[CurNbFid[5:0], CurNbDid]=[NbFid[5:0], NbDid] from [D18F5x16\[C:0\]](#) indexed by [D18F5x170](#)[NbPstateHi]. Go to step 15.
11. Write 1 to [D18F5x170](#)[SwNbPstateLoDis].
12. Wait for [D18F5x174](#)[CurNbPstate] = [D18F5x170](#)[NbPstateHi] and [D18F5x174](#)[CurNbFid[5:0], CurNbDid]=[NbFid[5:0], NbDid] from [D18F5x16\[C:0\]](#) indexed by [D18F5x170](#)[NbPstateHi].
13. Write 0 to [D18F5x170](#)[SwNbPstateLoDis, NbPstateDisOnP0, NbPstateThreshold].
14. Wait for [D18F5x174](#)[CurNbPstate] = [D18F5x170](#)[NbPstateLo] and [D18F5x174](#)[CurNbFid[5:0], CurNbDid]=[NbFid[5:0], NbDid] from [D18F5x16\[C:0\]](#) indexed by [D18F5x170](#)[NbPstateLo].



15. Set [D18F5x170](#)[SwNbPstateLoDis]=Temp1, [D18F5x170](#)[NbPstateDisOnP0]=Temp2, and [D18F5x170](#)[NbPstateThreshold]=Temp3, and [D18F5x170](#)[NbPstateGnbSlowDis]=Temp4.

#### 2.5.4.1.3.2 NB P-state Transitions

During boot when [D18F5x174](#)[NbPstateDis]=0, BIOS forces the processor to the desired NB P-states using the following steps:

1. Save the values in [D18F5x170](#) for later restoration to unforce the NB P-state.
2. Set the desired NB P-state pointers, [D18F5x170](#)[NbPstateHi, NbPstateLo].
3. Transition to the desired state as follows:
  - In order to transition to [D18F5x170](#)[NbPstateHi], program [D18F5x170](#) as follows:
    - SwNbPstateLoDis = 1.
    - Wait for [D18F5x174](#)[CurNbPstate] to equal NbPstateHi.
  - In order to transition to [D18F5x170](#)[NbPstateLo], program [D18F5x170](#) as follows:
    - SwNbPstateLoDis = NbPstateDisOnP0 = NbPstateThreshold = 0.
    - Wait for [D18F5x174](#)[CurNbPstate] to equal NbPstateLo.

BIOS performs the following to release the NB P-state force:

4. Release the NB P-state force by restoring initial [D18F5x170](#) values.
  - Restore the initial [D18F5x170](#)[SwNbPstateLoDis, NbPstateDisOnP0, NbPstateLo] values.
  - Restore the initial [D18F5x170](#)[NbPstateThreshold, NbPstateHi] values.

#### 2.5.4.1.3.3 NB P-state Configuration for Runtime

Please see your AMD representative for details.

#### 2.5.4.2 NB C-states

NB C-states are package-level actions that occur only when all cores enter a non-C0 state (see [2.5.3.2 \[Core C-states\]](#)). The NB C-state actions are:

- DRAM self-refresh (see [2.5.7.2 \[DRAM Self-Refresh\]](#)):
  - Enable bit: [D18F4x118/D18F4x11C](#)[SelfRefr].
  - Entry requirements:
    - No outstanding GPU traffic or traffic from a link.
  - Exit conditions (any of the following must be true):
    - The local APIC timer expires. See [2.4.9.1 \[Local APIC\]](#).
    - New GPU traffic or traffic from a link.
    - A P-state limit update (see [2.5.3.1.4 \[Core P-state Limits\]](#)) causes the most restrictive P-state limit to become a higher number than the current P-state for any core in CC1.
- NB clock gating:
  - Enable bit: [D18F4x118/D18F4x11C](#)[NbClkGate].
  - Entry requirements:
    - No outstanding GPU traffic or traffic from a link.
  - Exit conditions (any of the following must be true):
    - The local APIC timer expires. See [2.4.9.1 \[Local APIC\]](#).
    - New GPU traffic or traffic from a link.
    - A P-state limit update (see [2.5.3.1.4 \[Core P-state Limits\]](#)) causes the most restrictive P-state limit to become a higher number than the current P-state for any core in CC1.



NOTE: For SERVER system solutions, NB power gating should be disabled by setting [D18F4x118/D18F4x11C\[NbPwrGate\]](#) = 0 in the BIOS. BIOS setting of [D18F4x118/D18F4x11C\[NbPwrGate\]](#) = 1 should be set for client systems.

- NB power gating:
  - Enable bit: [D18F4x118/D18F4x11C\[NbPwrGate\]](#).
  - Entry requirements (all of the following must be true):
    - No outstanding GPU traffic or traffic from a link.
    - All cores are in CC6.
    - DRAM is either in or entering self-refresh.
  - Exit conditions (any of the following must be true):
    - The local APIC timer expires. See [2.4.9.1 \[Local APIC\]](#).
    - New GPU traffic or traffic from a link.
    - A P-state limit update (see [2.5.3.1.4 \[Core P-state Limits\]](#)) causes the most restrictive P-state limit to become a higher number than the current P-state for any core in CC1.

When entering NB C-states, the actions are taken in the following order:

1. DRAM self-refresh.
2. NB clock gating.
3. NB power gating.

When exiting NB C-states, the actions are taken in the following order:

1. NB power gating.
2. NB clock gating.
3. DRAM self-refresh.

### 2.5.4.3 Fuse Power Gating

Fuse controller can gate off power to its internal logic when no fuse activity is detected for a period of time. Fuse controller exits power gated state when it detects an event that requires access to the fuses.

### 2.5.5 Bandwidth Requirements

- The frequency relationship of (core COF / NB COF)  $\leq 6$  must be maintained for all supported P-state combinations. E.g., a core P0 COF of 4.0 GHz could not be combined with a NB P0 COF of 0.6 GHz; the NB P0 COF would have to be 0.8 GHz or greater; if the NB P0 COF is 1.2 GHz, then the NB P1 COF of 0.6 GHz may only be supported if the corresponding core P-state specify a COF of 3.0 GHz or less.
- All core P-states are required to be defined such that (NB COF/core COF)  $\leq 32$ , for all NB/core P-state combinations. E.g., if the NB COF is 4.8 GHz then the core COF must be no less than 150 MHz.
- All core P-states must be defined such that [CoreCOF](#)  $\geq 500$  MHz.
- All core P-states must be defined such that [MSRC001\\_00\[6B:64\]\[CpuFid\[5:0\]\]](#)  $\leq 22h$ .
- All NB P-states must be defined such that [D18F5x16\[C:0\]\[NbFid\[5:0\]\]](#)  $\leq 2Eh$ .
- [NBCOF](#)  $\geq$  MEMCLK frequency.
- [NBCOF](#)  $\geq 700$  MHz.
- [NBCOF](#)  $< 2.4$  GHz.

### 2.5.6 GPU and Root Complex Power Management

#### 2.5.6.1 Dynamic Power Management (DPM)

The processor supports dynamic GPU frequency changes along with VDDNB voltage change requests, known

as Dynamic Power Management (DPM). Once initialized, hardware dynamically monitors processor utilization and adjusts the frequencies and voltage based on that utilization. For DPM, higher numbered states represent higher performance and lower numbered states represent lower performance.

#### 2.5.6.1.1 Activity Monitors

The processor contains activity monitors which track the usage level of different processor subcomponents. A binary signal from each subcomponent is used to determine whether that subcomponent is busy. On each clock cycle, the activity monitor samples the signal from each unmasked subcomponent.

See [D0F0xBC\\_xC020\\_0110](#) for LCLK DPM activity monitor.

The output of the activity monitor is then used to determine whether the DPM state should be changed.

#### 2.5.6.1.2 SCLK DPM

SCLK DPM consists of up to 8 states. Any number of states up through 8 may be used and there is no requirement that the states be contiguous.

#### 2.5.6.1.3 LCLK DPM

LCLK DPM consists of up to 8 states. Any number of states up through 8 may be used and there is no requirement that the states be contiguous. Each state is made up of the following parameters.

- Valid bit: [D0F0xBC\\_x3FD\[8C:00:step14\]\[StateValid\]](#).
- Voltage change hysteresis threshold: [D0F0xBC\\_x3FD\[8C:00:step14\]\[LowVoltageReqThreshold\]](#).
- Divisor: [D0F0xBC\\_x3FD\[8C:00:step14\]\[LclkDivider\]](#).
- VID: [D0F0xBC\\_x3FD\[8C:00:step14\]\[VID\]](#).
  - See 2.5.2.2 [Dependencies Between Subcomponents on VDDNB].
- State change hysteresis thresholds: [D0F0xBC\\_x3FD\[94:08:step14\]\[HysteresisUp, HysteresisDown\]](#).
- Activity thresholds: [D0F0xBC\\_x3FD\[9C:10:step14\]\[ActivityThreshold\]](#).
- Residency counter: See [D0F0xBC\\_x3FD\[94:08:step14\]\[ResidencyCounter\]](#).

LCLK DPM is enabled by setting [D0F0xBC\\_x3FDC8\[LclkDpmEn\]](#). LCLK DPM voltage changes are enabled using [D0F0xBC\\_x3FDC8\[VoltageChgEn\]](#). When LCLK DPM is first enabled, the DPM state is transitioned to [D0F0xBC\\_x3FDC8\[LclkDpmBootState\]](#).

#### 2.5.6.2 GPU and Root Complex Power Gating

Several subcomponents of the GPU and root complex can be power gated when not in use.

- **GPU:** GPU power gating is initialized and enabled by software (see [GpuEnabled](#) and [D0F0x7C\[ForceIntGfxDisable\]](#)). Once initialized and enabled, the GPU is power gated by hardware when inactive and is ungated by hardware when needed. When internal GPU is disabled by BIOS, BIOS is responsible for power gating the GPU.
- **UVD:** UVD is power gated by software when not in use and is ungated by software when needed. UVD's internal state is not saved and UVD goes through an internal reset when power is restored.
- **GMC:** GMC power gating is initialized and enabled by software. Once initialized and enabled, GMC is power gated by hardware when inactive and is ungated by hardware when needed. GMC's state is saved internally. If the internal GPU is disabled, either by hardware (fusing) or by software, software is responsible

for power gating GMC.

- **VCE:** VCE is power gated by software when not in use and is ungated by software when needed. VCE's internal state is not saved and VCE goes through an internal reset when power is restored.
- **DCE:** DCE is power gated by software when there is no display connected. DCE's internal state is not saved and DCE goes through an internal reset when power is restored.
- **PCIe:** Any core that does not contain the UMI link can be power gated when it is not in use. In addition, the individual phys on the TX and RX sides of each link can be power gated when the links are not connected. During POST and runtime, several software components inform the SMU whether the link core or the link phys are in use. SMU power gates or ungates the link core and the link phys as needed.

## 2.5.7 DRAM Power Management

### 2.5.7.1 Memory P-states

The processor supports up to 2 memory P-states, M0 and M1. Each memory P-state consists of the following:

- MEMCLK frequency
- A set of frequency dependent DRAM timing and configuration registers

See [2.9 \[DRAM Controllers \(DCTs\)\]](#) for DRAM technology specific information and requirements.

All valid memory P-states are associated with a specific NB P-state, as specified by [D18F5x16\[C:0\]\[MemPstate\]](#). When hardware transitionsto a new NB P-state, the memory P-state is transitioned to that specified by the new NB P-state.

Out of cold reset the current memory P-state is M0. The P-state value specified by [D18F5x16\[C:0\]\[MemPstate\]](#) of the NB P-state indexed by [D18F5x174\[StartupNbPstate\]](#) is invalid. Support for dynamic memory P-state changes is indicated by [D18F3xE8\[MemPstateCap\]=1](#) and one or more [D18F5x16\[C:0\]\[MemPstate\]=1](#); otherwise M0 is used by hardware for configuration purposes.

During boot, and if [D18F5x170\[MemPstateDis\]=0](#), the BIOS can disable memory P-states using the following steps:

1. Program [D18F5x170\[MemPstateDis\]=1](#).
2. Program [D18F5x16\[C:0\]\[MemPstate\]=0](#).

### 2.5.7.2 DRAM Self-Refresh

DRAM is placed into self-refresh on S3 entry (see [2.5.8.1.1 \[ACPI Suspend to RAM State \(S3\)\]](#)).

In addition to S3, DRAM is placed into self-refresh in S0 in the following two scenarios:

- NB P-state transitions (see [2.5.4.1 \[NB P-states\]](#)).
- NB C-states (see [2.5.4.2 \[NB C-states\]](#)).

The following requirements must be met before hardware places DRAM into self-refresh:

- No pending traffic.
- One of the following is true:
  - The GPU is idle and the internal display buffer is full.
  - The internal GPU is disabled.

Once the above requirements are met, hardware places DRAM into self-refresh.

Early self-refresh occurs when DRAMs are placed in self-refresh before expiration of the cache flush timer. See [D18F4x118/D18F4x11C\[SelfRefrEarly\]](#) and [D18F5x128\[SelfRefrEarlyDis\]](#). If early self-refresh is enabled, the DRAMs are taken out of self-refresh to perform the flush operation when the cache flush timer expires and then placed back into self-refresh.

The following are events that cause DRAM to transition out of self-refresh:

- Core transitioning to C0.
- Incoming request from any link or the GMC
- P-state limit update, only in the case when all cores are not in the power gated (CC6) state.

To save additional power, hardware always tristates MEMCLK when entering self-refresh.

### 2.5.7.3 Stutter Mode

DRAM is most commonly placed in self-refresh due to stutter mode when the internal GPU is in use. The display buffer in the GPU is a combination of a large buffer known as the DMIF (Display Memory Interface FIFO) and a smaller line buffer. The DMIF takes data originating from DRAM and sends it to the line buffer to draw to the screen. When the data level in the DMIF is full, DRAM is placed in self-refresh, and incoming DRAM requests are queued. As the DMIF drains, it eventually falls below a predefined watermark level, at which point hardware pulls DRAM out of self-refresh and services all the requests in the queue. Once all the requests are complete and the DMIF is full again, a transition back into self-refresh occurs if the stutter mode conditions are still met.

#### 2.5.7.3.1 System BIOS Requirements for Stutter Mode Operation During POST

BIOS creates a data structure in memory containing information about the processor for use by the driver. Please see your AMD representative for more information.

### 2.5.7.4 EVENT\_L

EVENT\_L is a level sensitive input to the processor. When asserted, the actions specified by [D18F2xA4](#) are taken. EVENT\_L is generally asserted to indicate that a DRAM high temperature condition exists. The minimum assertion time for EVENT\_L is 15 ns. The minimum deassertion time for EVENT\_L is 15 ns.

- EVENT\_L is pulled to VDDIO on the motherboard.
- EVENT\_L is ignored while:
  - PWROK is de-asserted.
  - RESET\_L is asserted.
- BIOS must ensure that throttling is disabled (see [D18F2xA4\[CmdThrottleMode\]](#)) until DRAM training is complete.

See [2.9.14 \[DRAM On DIMM Thermal Management and Power Capping\]](#).

## 2.5.8 System Power Management

### 2.5.8.1 S-states

S-states are ACPI defined sleep states. S0 is the operational state. All other S-states are low-power states in which various voltage rails in the system may or may not be powered. See the ACPI specification for descriptions of each S-state. The only other S-state supported is S5.

### 2.5.8.1.1 ACPI Suspend to RAM State (S3)

The processor supports the ACPI-defined S3 state. Software is responsible for restoring the state of the processor's registers when resuming from S3. All registers in the processor that BIOS initialized during the initial boot must be restored. The method used to restore the registers is system specific.

During S3 entry, software is responsible for transitioning the processor to Memory Pstate0. See [2.5.7.1 \[Memory P-states\]](#).

During S3 entry, system memory enters self-refresh mode (see [2.5.7.2 \[DRAM Self-Refresh\]](#)). Software is responsible for bringing memory out of self-refresh mode when resuming from S3. To bring memory out of self-refresh mode. See [2.9.9 \[DCT/DRAM Initialization and Resume\]](#).

Many of the systemboard power planes for the processor are powered down during S3. Refer to the Electrical Data Sheet for the following:

- Power plane electrical requirements during S3.
- Power plane sequencing requirements on S3 entry and exit.
- System signal states for both inputs (e.g. PWROK and RESET\_L) and outputs (e.g. VID[\*], PSI\_L bit, THERMTRIP\_L, etc.) during S3.
- System signal sequencing requirements on S3 entry and exit.
- System management message sequencing on S3 entry and exit.

## 2.5.9 Application Power Management (APM)

Application Power Management (APM) allows the processor to deterministically provide maximum performance while remaining within the specified power delivery and removal envelope. APM dynamically monitors processor activity and generates an approximation of power consumption. If power consumption exceeds a defined power limit, a P-state limit is applied by APM hardware to reduce power consumption. APM ensures that average power consumption over a thermally significant time period remains at or below the defined power limit. This allows P-states to be defined with higher frequencies and voltages than could be used without APM.

### 2.5.9.1 Core Performance Boost (CPB)

These P-states are referred to as boosted P-states.

- Support for APM is specified by [CPUID Fn8000\\_0007\\_EDX\[CPB\]](#).
- APM is enabled if all of the following conditions are true:
  - [MSRC001\\_0015\[CpbDis\]](#) = 0 for all cores.
  - [D18F4x15C\[ApmMasterEn\]](#) = 1.
  - [D18F4x15C\[BoostSrc\]](#) = 01b.
  - [D18F4x15C\[NumBoostStates\]](#) != 0.
- APM can be dynamically enabled and disabled through [MSRC001\\_0015\[CpbDis\]](#). If core performance boost (CPB) is disabled, a P-state limit is applied. The P-state limit restricts cores to the highest performance non-boosted P-state.
- All P-states, both boosted and non-boosted, are specified in [MSRC001\\_00\[6B:64\]](#).
- The number of boosted P-states is specified by [D18F4x15C\[NumBoostStates\]](#).
  - The number of boosted P-states may vary from product to product.
- Two levels of boosted P-states are supported. Compute units can be placed in the first level of boosted P-states if the processor power consumption remains within the TDP limit. The second level of boosted P-

states is C-state Boost. See [2.5.9.1.1 \[C-state Boost\]](#).

- All boosted P-states are always higher performance than non-boosted P-states.
- To ensure proper operation, boosted P-states should be hidden from the operating system. BIOS should not provide ACPI \_PSS entries for boosted P-states. See [2.5.3.1.8.3.2 \[\\_PSS \(Performance Supported States\)\]](#).
- The lowest-performance P-state CPB limits the processor to is the highest-performance non-boosted P-state.

#### **2.5.9.1.1 C-state Boost**

C-state Boost can only be achieved if a subset of cores/compute units are in CC6 and the processor power consumption remains within the TDP limit. See [D18F4x16C](#)[CstateCnt, CstateBoost, CstateCores].

#### **2.5.9.2 TDP Limiting**

TDP limiting is a mechanism for capping the power consumption of the processor through a TDP limit.

#### **2.5.9.3 Bidirectional Application Power Management (BAPM)**

Bidirectional Application Power Management (BAPM) is an algorithm to enable fine grained power transfers between the core and GPU.

#### **2.5.9.4 Configurable TDP (cTDP)**

Configurable TDP (cTDP) provides flexibility to AMD APU, traditionally defined to be at fixed nominal TDPs, to fit well in platforms that have thermal solutions designed for lower than nominal TDP. For example, a 35W OPN with the cTDP feature will be able to function and perform well in platforms designed for 30W.

## 2.6 Performance Monitoring

The processor includes support for two methods of monitoring processor performance:

- [2.6.1 \[Performance Monitor Counters\]](#).
- [2.6.2 \[Instruction Based Sampling \(IBS\)\]](#).

### 2.6.1 Performance Monitor Counters

The following types of performance counters are supported:

- [2.6.1.1 \[Core Performance Monitor Counters\]](#), consisting of one set located in each core of each compute unit.
- [2.6.1.2 \[NB Performance Monitor Counters\]](#), consisting of one set located in each node.

The accuracy of the performance counters is not ensured. The performance counters are not assured of producing identical measurements each time they are used to measure a particular instruction sequence, and they should not be used to take measurements of very small instruction sequences. The RDPMC instruction is not serializing, and it can be executed out-of-order with respect to other instructions around it. Even when bound by serializing instructions, the system environment at the time the instruction is executed can cause events to be counted before the counter value is loaded into EDX:EAX.

To accurately start counting with the write that enables the counter, disable the counter when changing the event and then enable the counter with a second MSR write.

Writing the performance counters can be useful if there is an intention for software to count a specific number of events, and then trigger an interrupt when that count is reached. An interrupt can be triggered when a performance counter overflows. Software should use the WRMSR instruction to load the count as a two's-complement negative number into the performance counter. This causes the counter to overflow after counting the appropriate number of times.

In addition to the RDMSR instruction, the performance counter registers can be read using a special read performance-monitoring counter instruction, RDPMC.

#### 2.6.1.1 Core Performance Monitor Counters

The core performance monitor counters are used by software to count specific events that occur in a core of the compute unit. Each core of each compute unit provides six 48-bit performance counters. Unless otherwise specified, the events count only the activity of the core, not activity caused by the other core of the compute unit.

[MSRC001\\_020\[A,8,6,4,2,0\]](#) [Performance Event Select (PERF\_CTL[5:0])] specify the events to be monitored and how they are monitored. [MSRC001\\_020\[B,9,7,5,3,1\]](#) [Performance Event Counter (PERF\_CTR[5:0])] are the counters. [MSRC001\\_00\[03:00\]](#) is the legacy alias for [MSRC001\\_020\[6,4,2,0\]](#). [MSRC001\\_00\[07:04\]](#) is the legacy alias for [MSRC001\\_020\[7,5,3,1\]](#). Support for [MSRC001\\_020\[B:0\]](#) is indicated by [CPUID Fn8000\\_0001\\_ECX\[PerfCtrExtCore\]](#).

All of the events are specified in [3.23 \[Core Performance Counter Events\]](#).

Some performance monitor events have a maximum count per clock that exceeds one event per clock. These performance events are called multi-events. Some counters support a greater multi-event count per clock than others. Events that are multi-events will specify the maximum multi-event count per clock. E.g. The number of events logged per cycle can vary from 0 to X. An event that doesn't specify multi-event is implied to be a max-



imum of 1 event per clock. Undefined results will be produced if an multi-event is selected that exceeds that counters capabilities. The following list specifies the maximum number of multi-events supported by each counter:

- PERF\_CTL[0]: 31 multi-event per clock maximum.
- PERF\_CTL[1]: 7 multi-event per clock maximum.
- PERF\_CTL[2]: 7 multi-event per clock maximum.
- PERF\_CTL[3]: 63 multi-event per clock maximum.
- PERF\_CTL[4]: 7 multi-event per clock maximum.
- PERF\_CTL[5]: 7 multi-event per clock maximum.

Not all performance monitor events can be counted on all counters. The performance counter registers are generally assigned to specific blocks of the core according to [Table 12](#); however, there are exceptions when an events is implemented by another block of the core and therefore has the counter restrictions of that block. Each core event description starts with one of the following terms to indicate which counters support that event. Selecting an event for a counter that does not support that counter will produce undefined results.

**Table 12: Core PMC mapping to PERF\_CTL[5:0]**

| Term                 | Definition                                                                                                                         |
|----------------------|------------------------------------------------------------------------------------------------------------------------------------|
| <b>PERF_CTL[5:0]</b> | PERF_CTL[5:0] are used to count events in the LS/DC and EX where the number of events logged per cycle can vary up to 7.           |
| <b>PERF_CTL[3,0]</b> | PERF_CTL[3,0] are used to count events in the LS/DC and EX where the number of events logged per cycle can vary up to 31.          |
| <b>PERF_CTL[0]</b>   | PERF_CTL[0] are used to count events in the LS/DC, EX, IF/DE and CU where the number of events logged per cycle can vary up to 31. |
| <b>PERF_CTL[3]</b>   | PERF_CTL[3] are used to count events in the LS/DC, EX and FP where the number of events logged per cycle can vary up to 63.        |
| <b>PERF_CTL[2:0]</b> | PERF_CTL[2:0] are used to count events in the IF/DE and CU; The number of events logged per cycle can vary up to 7.                |
| <b>PERF_CTL[5:3]</b> | PERF_CTL[5:3] are used to count events in the FP; The number of events logged per cycle can vary up to 7.                          |

### 2.6.1.2 NB Performance Monitor Counters

The NB performance monitor counters are used by software to count specific events that occur in the NB. Each node provides four 48-bit performance counters. Since the northbridge performance counter register are shared by all cores on a node, monitoring of northbridge events should only be performed by one core on a node.

[MSRC001\\_024\[6,4,2,0\]](#) [Northbridge Performance Event Select (NB\_PERF\_CTL[3:0])] and [MSRC001\\_024\[7,5,3,1\]](#) [Northbridge Performance Event Counter (NB\_PERF\_CTR[3:0])] specify the events to be monitored and how they are monitored. Support for [MSRC001\\_024\[7:0\]](#) is indicated by [CUID Fn8000\\_0001\\_ECX\[PerfCtrExtNB\]](#).

All of the events are specified in [3.24 \[NB Performance Counter Events\]](#).

All NB performance monitor events can be counted on all counters.

All NB performance events are one event per clock.

NB performance counters do not support APIC interrupt capability.



## 2.6.2 Instruction Based Sampling (IBS)

IBS is a code profiling mechanism that enables the processor to select a random instruction fetch or micro-op after a programmed time interval has expired and record specific performance information about the operation. An interrupt is generated when the operation is complete as specified by [MSRC001\\_103A \[IBS Control\]](#). An interrupt handler can then read the performance information that was logged for the operation.

The IBS mechanism is split into two parts: instruction fetch performance controlled by [MSRC001\\_1030 \[IBS Fetch Control \(IbsFetchCtl\)\]](#); and instruction execution performance controlled by [MSRC001\\_1033 \[IBS Execution Control \(IbsOpCtl\)\]](#). Instruction fetch sampling provides information about instruction TLB and instruction cache behavior for fetched instructions. Instruction execution sampling provides information about micro-op execution behavior. The data collected for instruction fetch performance is independent from the data collected for instruction execution performance. Support for the IBS feature is indicated by the [CPUID Fn8000\\_0001\\_ECX\[IBS\]](#).

Instruction fetch performance is profiled by recording the following performance information for the tagged instruction fetch:

- If the instruction fetch completed or was aborted. See [MSRC001\\_1030](#).
- The number of clock cycles spent on the instruction fetch. See [MSRC001\\_1030](#).
- If the instruction fetch hit or missed the IC, hit/missed in the L1 and L2 TLBs, and page size. See [MSRC001\\_1030](#).
- The linear address, physical address associated with the fetch. See [MSRC001\\_1031](#), [MSRC001\\_1032](#).

Instruction execution performance is profiled by tagging one micro-op associated with an instruction. Instructions that decode to more than one micro-op return different performance data depending upon which micro-op associated with the instruction is tagged. These micro-ops are associated with the RIP of the next instruction to retire. The following performance information is returned for the tagged micro-op:

- Branch and execution status for micro-ops. See [MSRC001\\_1035](#).
- Branch target address for branch micro-ops. See [MSRC001\\_103B](#).
- The logical address associated with the micro-op. See [MSRC001\\_1034](#).
- The linear and physical address associated with a load or store micro-op. See [MSRC001\\_1038](#), [MSRC001\\_1039](#).
- The data cache access status associated with the micro-op: DC hit/miss, DC miss latency, TLB hit/miss, TLB page size. See [MSRC001\\_1037](#).
- The number clocks from when the micro-op was tagged until the micro-op retires. See [MSRC001\\_1035](#).
- The number clocks from when the micro-op completes execution until the micro-op retires. See [MSRC001\\_1035](#).
- Source information for DRAM and MMIO. See [MSRC001\\_1036](#).

## 2.7 Configuration Space

PCI-defined configuration space was originally defined to allow up to 256 bytes of register space for each function of each device; these first 256 bytes are called base configuration space (BCS). It was expanded to support up to 4096 bytes per function; bytes 256 through 4095 are called extended configuration space (ECS). The processor includes configuration space registers located in both BCS and ECS. Processor configuration space is accessed through bus 0, devices 18h to 1Fh, where device 18h corresponds to node 0 and device 1Fh corresponds to node 7. See [2.7.3 \[Processor Configuration Space\]](#).

Configuration space is accessed by the processor through two methods:

- IO-space configuration: IO instructions to addresses CF8h and CFCh.
  - Enabled through [IOCF8\[ConfigEn\]](#), which allows access to BCS.
  - Access to ECS enabled through [MSRC001\\_001F\[EnableCf8ExtCfg\]](#).
  - Use of IO-space configuration can be programmed to generate GP faults through [MSRC001\\_0015\[IoCf-gGpFault\]](#).
  - SMI trapping for these accesses is specified by [MSRC001\\_0054 \[IO Trap Control \(SMI\\_ON\\_IO\\_TRAP\\_CTL\\_STS\)\]](#) and [MSRC001\\_00\[53:50\] \[IO Trap \(SMI\\_ON\\_IO\\_TRAP\\_\[3:0\]\)\]](#).
- MMIO configuration: configuration space is a region of memory space.
  - The base address and size of this range is specified by [MSRC001\\_0058 \[MMIO Configuration Base Address\]](#). The size is controlled by the number of configuration-space bus numbers supported by the system. Accesses to this range are converted configuration space as follows:
    - Address[31:0] = {0h, bus[7:0], device[4:0], function[2:0], offset[11:0]}.

The BIOS may use either configuration space access mechanism during boot. Before booting the OS, BIOS must disable IO access to ECS, enable MMIO configuration and build an ACPI defined MCFG table. BIOS ACPI code must use MMIO to access configuration space.

Per the link specification, BCS accesses utilize link addresses starting at FD\_FE00\_0000h and ECS accesses utilize link addresses starting at FE\_0000\_0000h.

### 2.7.1 MMIO Configuration Coding Requirements

MMIO configuration space accesses must use the uncacheable (UC) memory type.

Instructions used to read MMIO configuration space are required to take the following form:

```
mov eax/ax/al, any_address_mode;
```

Instructions used to write MMIO configuration space are required to take the following form:

```
mov any_address_mode, eax/ax/al;
```

No other source/target registers may be used other than eax/ax/al.

In addition, all such accesses are required not to cross any naturally aligned DW boundary. Access to MMIO configuration space registers that do not meet these requirements result in undefined behavior.

### 2.7.2 MMIO Configuration Ordering

Since MMIO configuration cycles are not serializing in the way that IO configuration cycles are, their ordering rules relative to posted may result in unexpected behavior.

Therefore, processor MMIO configuration space is designed to match the following ordering relationship that exists naturally with IO-space configuration: if a core generates a configuration cycle followed by a posted-write cycle, then the posted write is held in the processor until the configuration cycle completes. As a result, any unexpected behavior that might have resulted if the posted-write cycle were to pass MMIO configuration cycle is avoided.

### 2.7.3 Processor Configuration Space

The processor includes configuration space as described in [3 \[Registers\]](#). Accesses to unimplemented registers

of implemented functions are ignored: writes dropped; reads return 0. Accesses to unimplemented functions also ignored: writes are dropped; however, reads return all F's. The processor does not log any master abort events for accesses to unimplemented registers or functions.

Accesses to device numbers of devices not implemented in the processor are routed based on the configuration map registers. If such requests are master aborted, then the processor can log the event.

## 2.8 Northbridge (NB)

Each node includes a single northbridge that provides the interface to the local core(s), the interface to system memory, and the interface to system IO devices. The NB includes all power planes except VDD; see [2.5.1 \[Processor Power Planes And Voltage Control\]](#).

The NB is responsible for routing transactions sourced from cores and link to the appropriate core, cache, DRAM, or link. See [2.4.6 \[System Address Map\]](#).

### 2.8.1 NB Architecture

Major NB blocks are: System Request Interface (SRI), Memory Controller (MCT), DRAM Controllers (DCTs), and crossbar (XBAR). SRI interfaces with the core(s). MCT maintains cache coherency and interfaces with the DCTs; MCT maintains a queue of incoming requests called MCQ. XBAR is a switch that routes packets between SRI, MCT, and the link.

The MCT operates on physical addresses. Before passing transactions to the DCTs, the MCT converts physical addresses into *normalized* addresses that correspond to the values programmed into [D18F2x\[5C:40\]\\_dct\[3:0\] \[DRAM CS Base Address\]](#). Normalized addresses include only address bits within the DCTs' range.

### 2.8.2 NB Routing

#### 2.8.2.1 Address Space Routing

There are four main types of address space routed by the NB:

1. Memory space targeting system DRAM
2. Memory space targeting IO (MMIO)
3. IO space
4. Configuration space.

##### 2.8.2.1.1 DRAM and MMIO Memory Space

Memory space transactions provide the NB with the physical address, cacheability type, access type, and DRAM/MMIO destination type as specified in section [2.4.6.1.2 \[Determining The Access Destination for Core Accesses\]](#).

Memory-space transactions are handled by the NB as follows:

- IO-device accesses are compared against:
  - If the access matches [D18F1x\[2CC:2A0,1CC:180,BC:80\] \[MMIO Base/Limit\]](#), then the transaction is routed to the root complex;
  - Else, if the access matches [D18F1x\[17C:140,7C:40\] \[DRAM Base/Limit\]](#), then the access is routed to the DCT;
  - Else, the access is routed to the UMI.
- For core accesses the routing is determined based on the DRAM/MMIO destination:
  - If the destination is DRAM:
    - If the access matches [D18F1x\[17C:140,7C:40\] \[DRAM Base/Limit\]](#), then the transaction is routed

- to the DCT;
- Else, the access is routed to the UMI.
- If the destination is MMIO:
  - If the access matches the VGA-compatible MMIO address space and [D18F1xF4\[VE\]=1](#) then [D18F1xF4](#) describes how the access is routed and controlled;
  - Else, If the access matches [D18F1x\[2CC:2A0,1CC:180,BC:80\]](#) [MMIO Base/Limit], then the transaction is routed to the root complex;
  - Else, the access is routed to the UMI.

#### 2.8.2.1.2 IO Space

IO-space transactions from IO links or cores are routed as follows:

- If the access matches [D18F1x\[DC:C0\]](#) [IO-Space Base/Limit], then the transaction is routed to the root complex;
- Else, If the access matches the VGA-compatible IO address space and [D18F1xF4\[VE\]=1](#) then [D18F1xF4](#) describes how the access is routed and controlled.
- Else, the access is routed to the UMI.

#### 2.8.2.1.3 Configuration Space

Configuration-space transactions from IO links are master aborted. Configuration-space transactions from cores are routed as follows:

- If the access matches [D18F1x\[1DC:1D0,EC:E0\]](#) [Configuration Map], then the transaction is routed to the specified link;
- Else, the access is routed to link that contains compatibility (subtractive) address space.

### 2.8.2.1.3.1 Recommended Buffer Count Settings Overview

When changing from the recommended settings, see the register programming requirements in the definition of each register. Some chipsets may further optimize these settings for their platform. If values other than the recommended settings are used, see the register requirements in the definition of each register. [Table 13](#) defines commonly used terms for the following tables.

**Table 13: ONION Link Definitions**

| Term              | Definition                                                                                                                                                                      |
|-------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>LinkGanged</b> | Ganged = 0.                                                                                                                                                                     |
| <b>IOMMU</b>      | Indicates the presence of an IOMMU device on the IOH. IOMMU uses the isochronous flow control channel. If an IOMMU is present, D18F0x[A4,84][IsocEn] must be set for all links. |
| <b>IFCM</b>       | Isochronous Flow Control Mode. IFCM = D18F0x[A4,84][IsocEn].                                                                                                                    |

### 2.8.3 Memory Scrubbers

The processor includes memory scrubbers specified in [D18F3x58](#), [D18F3x5C](#), and [D18F3x60](#). The scrubbers ensure that all cachelines in memory within or connected to the processor are periodically read and, if correctable errors are discovered, they are corrected.

For recommendations on scrub rates, see [2.15.1.8 \[Scrub Rate Considerations\]](#).

The scrub rate is specified as the time between successive scrub events. A scrub event occurs when a line of memory is checked for errors; the amount of memory that is checked varies based on the memory block (see field descriptions).

The time required to fully scrub the memory of a node is determined as:

- $\text{Time} = ((\text{memory size in bytes})/64) * (\text{Scrub Rate})$ .
- E.g. If a node contains 1GB of system memory and  $\text{DramScrub} = 5.24 \text{ ms}$ , then all of the system memory of the node is scrubbed about once every 23 hours.

## 2.9 DRAM Controllers (DCTs)

The processor includes two DRAM controllers (DCTs), named DCT0 and DCT3. Each DCT controls one 64-bit DDR3 DRAM channel as shown in the following table. Software must not attempt to configure “DCT1” or “DCT2”.

**Table 14: DCT Channel Ctrl Map**

| Channel   |      |      |           |
|-----------|------|------|-----------|
| DCT0      | DCT2 | DCT1 | DCT3      |
| Channel A | -    | -    | Channel B |

The following restrictions limit the DIMM types and configurations supported by the DCTs:

- All DIMMs connected to the processor are required to operate at the same MEMCLK frequency.
- Registered DIMMs are not supported.
- LR-DIMMs are not supported.
- Quad rank DIMMs are not supported.
- x4(by 4) DRAM devices are not supported.
- ECC DIMMs are supported on FP3 package
  - Mixing of ECC and non-ECC DIMMs within a system is not supported
- ECC DIMMs are not supported on FM2r2 package
- GDDR5 memory is not supported.

### 2.9.1 Common DCT Definitions

**Table 15: DCT Definitions**

| Term                   | Definition                                                                                                                                                                                                                                                                                                                                                                                                       |      |             |     |            |     |                              |     |                               |
|------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|-----|------------|-----|------------------------------|-----|-------------------------------|
| <b>any</b>             | Any: <a href="#">SR</a> or <a href="#">DR</a> .                                                                                                                                                                                                                                                                                                                                                                  |      |             |     |            |     |                              |     |                               |
| <b>AutoSelfRefresh</b> | SPDByte[31][2] of the DIMM being configured.                                                                                                                                                                                                                                                                                                                                                                     |      |             |     |            |     |                              |     |                               |
| <b>DataMaskMbType</b>  | Motherboard type for processor Data Mask pins.<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>No connect</td></tr> <tr> <td>01b</td><td>Pins are routed per DM rules</td></tr> <tr> <td>10b</td><td>Pins are routed per DQS rules</td></tr> </table>                                                                                                                                | Bits | Description | 00b | No connect | 01b | Pins are routed per DM rules | 10b | Pins are routed per DQS rules |
| Bits                   | Description                                                                                                                                                                                                                                                                                                                                                                                                      |      |             |     |            |     |                              |     |                               |
| 00b                    | No connect                                                                                                                                                                                                                                                                                                                                                                                                       |      |             |     |            |     |                              |     |                               |
| 01b                    | Pins are routed per DM rules                                                                                                                                                                                                                                                                                                                                                                                     |      |             |     |            |     |                              |     |                               |
| 10b                    | Pins are routed per DQS rules                                                                                                                                                                                                                                                                                                                                                                                    |      |             |     |            |     |                              |     |                               |
| <b>Ddr3Mode</b>        | The DRAM controller and the phy are configured for DDR3 mode. Note: this mode may not be supported by this processor. See section 2.9, or consult processor data sheet to determine which modes are supported. See <a href="#">D18F2x78_dct[3:0][DramType]</a> , <a href="#">D18F2x9C_x00[F,3:0]0_[F,B:0]04A_dct[3:0][MajorMode]</a> , and <a href="#">D18F2x9C_x00[F,8:0]1_[F,B:0]04A_dct[3:0][MajorMode]</a> . |      |             |     |            |     |                              |     |                               |
| <b>DdrRate</b>         | The DDR data rate (MT/s) as specified by (if Ddr3Mode then <a href="#">D18F2x94_dct[3:0][MemClkFreq]</a> and <a href="#">D18F2x2E0_dct[3:0][M1MemClkFreq]</a> ).                                                                                                                                                                                                                                                 |      |             |     |            |     |                              |     |                               |
| <b>DeviceWidth</b>     | DDR3 SPDByte[7][2:0] of the DIMM being configured.                                                                                                                                                                                                                                                                                                                                                               |      |             |     |            |     |                              |     |                               |
| <b>DIMM</b>            | The DIMM being configured                                                                                                                                                                                                                                                                                                                                                                                        |      |             |     |            |     |                              |     |                               |

**Table 15: DCT Definitions**

| Term                             | Definition                                                                                                                                                                                                      |
|----------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>DIMM0</b>                     | DIMM slots 0-n. The DIMMs on each channel are numbered from 0 to n where                                                                                                                                        |
| <b>DIMM1</b>                     | DIMM0 is the DIMM closest to the processor on that channel and DIMMn is the DIMM farthest from the processor on that channel.                                                                                   |
| <b>DimmsPopulated</b>            | The number of DIMMs populated per channel plus rows of <a href="#">Solder-down DRAM</a> devices.                                                                                                                |
| <b>DR</b>                        | Dual Rank                                                                                                                                                                                                       |
| <b>DramCapacity</b>              | DDR3 SPDByte[4][3:0] of the DIMM being configured.                                                                                                                                                              |
| <b>ExtendedTemperature-Range</b> | DDR3 SPDByte[31][0] of the DIMM being configured.                                                                                                                                                               |
| <b>Gddr5Mode</b>                 | The DRAM controller and the phy are configured for GDDR5 mode. Note: this mode may not be supported by this processor. See section 2.9, or consult processor data sheet to determine which modes are supported. |
| <b>MaxDct</b>                    | The range of values supported by <a href="#">D18F1x10C[DctCfgSel]</a> for registers with the mnemonic <a href="#">D18F2xXXX_dct[MaxDct:0]</a> . MaxDct = 3. See 2.9.3 [DCT Configuration Registers].            |
| <b>MaxDctMstr</b>                | The range of values supported by <a href="#">D18F1x10C[DctCfgSel]</a> for registers with the mnemonic <a href="#">D18F2x[B,0]9[C,8]_xXXXX_XXXX_dct[MaxDctMstr:0]</a> . See 2.9.3 [DCT Configuration Registers]. |
| <b>MRS</b>                       | JEDEC defined DRAM Mode Register Set.                                                                                                                                                                           |
| <b>NP</b>                        | No DIMM populated                                                                                                                                                                                               |
| <b>NumDimmSlots</b>              | The number of motherboard DIMM slots per channel plus rows of <a href="#">Solder-down DRAM</a> devices                                                                                                          |
| <b>NumRanks</b>                  | DDR3 SPDByte[7][5:3] of the DIMM being configured, or the number of ranks soldered down.                                                                                                                        |
| <b>Rank</b>                      | The rank being configured                                                                                                                                                                                       |
| <b>RankMap</b>                   | DDR3 SPDByte[63][0] of the DIMM being configured. .                                                                                                                                                             |
| <b>RowAddrBits</b>               | DDR3 SPDByte[5][5:3] of the DIMM being configured.                                                                                                                                                              |
| <b>Solder-down DRAM</b>          | DRAM devices soldered directly to the motherboard.                                                                                                                                                              |
| <b>SODIMM</b>                    | DCT is configured for SODIMM if ( <a href="#">D18F2x90_dct[3:0][UnbuffDimm]==1</a> ) and SODIMMs are populated.                                                                                                 |
| <b>SPD</b>                       | Serial Presence Detect. In the case of DRAMs soldered on the platform, this refers to a virtual representation of the DRAM vendors' data sheets.                                                                |
| <b>SR</b>                        | Single Rank                                                                                                                                                                                                     |
| <b>UDIMM</b>                     | DCT is configured for UDIMM if ( <a href="#">D18F2x90_dct[3:0][UnbuffDimm]==1</a> ) and UDIMMs are populated.                                                                                                   |
| <b>VDDIO</b>                     | DDR VDDIO in V.                                                                                                                                                                                                 |

## 2.9.2 DCT Frequency Support

The tables below list the maximum DIMM speeds supported by the processor for different configurations. The motherboard should comply with the relevant AMD socket motherboard design guideline (MBDG) to achieve the rated speeds. In cases where MBDG design options exist, lower-quality options may compromise the maximum achievable speed; motherboard designers should assess the tradeoffs.

The FP3 package supports two different voltage levels on the VDDR rail. At the 1.05V nominal setting, the maximum speed of 2133 can be supported while at the 0.95V setting, the maximum speed supported is 1600. See 2.11.3.1 for its effect on PCIe data rate.

Table 16: DDR3 **UDIMM** Maximum Frequency Support for FM2r2 package

| Num-DimmSlots | DimmsPopulated | DRAM |    | Frequency <sup>1</sup> (MT/s) |       |       |
|---------------|----------------|------|----|-------------------------------|-------|-------|
|               |                | SR   | DR | 1.5V                          | 1.35V | 1.25V |
| 1             | 1              | 1    | -  | 2133                          | 1866  | 1600  |
|               |                | -    | 1  | 1866                          | 1600  | 1600  |
| 2             | 1              | 1    | -  | 1866                          | 1600  | 1333  |
|               |                | -    | 1  | 1866                          | 1600  | 1333  |
|               | 2              | 2    | -  | 1866                          | 1600  | 1333  |
|               |                | 1    | 1  | 1600                          | 1333  | 1333  |
|               |                | -    | 2  | 1600                          | 1333  | 1333  |
|               |                |      |    |                               |       |       |

1. Population restrictions (including the order for partially populated channels) may apply. Num-DimmSlots and DimmsPopulated are per channel.

2.

Table 17: DDR3 **UDIMM** Maximum Frequency Support for FP3 package

| Num-DimmSlots | DimmsPopulated | DRAM |    | Frequency <sup>1</sup> (MT/s) |       |       |
|---------------|----------------|------|----|-------------------------------|-------|-------|
|               |                | SR   | DR | 1.5V                          | 1.35V | 1.25V |
| 1             | 1              | 1    | -  | 2133                          | 1866  | 1600  |
|               |                | -    | 1  | 1866                          | 1600  | 1600  |
| 2             | 1              | 1    | -  | 2133                          | 1866  | 1600  |
|               |                | -    | 1  | 1866                          | 1600  | 1600  |
|               | 2              | 2    | -  | 1866                          | 1600  | 1333  |
|               |                | 1    | 1  | 1600                          | 1333  | 1333  |
|               |                | -    | 2  | 1600                          | 1333  | 1333  |
|               |                |      |    |                               |       |       |

1. Population restrictions (including the order for partially populated channels) may apply. Num-DimmSlots and DimmsPopulated are per channel.

2.

Table 18: DDR3 **SODIMM** Maximum Frequency Support for FM2r2 package

| Num-DimmSlots | DimmsPopulated | DRAM |    | Frequency <sup>1</sup> (MT/s) |       |       |
|---------------|----------------|------|----|-------------------------------|-------|-------|
|               |                | SR   | DR | 1.5V                          | 1.35V | 1.25V |
| 1             | 1              | 1    | -  | 2133                          | 1866  | 1600  |
|               |                | -    | 1  | 1866                          | 1600  | 1600  |



Table 18: DDR3 SODIMM Maximum Frequency Support for FM2r2 package

| Num-DimmSlots | DimmsPopulated | DRAM |    | Frequency <sup>1</sup> (MT/s) |       |       |
|---------------|----------------|------|----|-------------------------------|-------|-------|
|               |                | SR   | DR | 1.5V                          | 1.35V | 1.25V |
| 2             | 1              | 1    | -  | 1600                          | 1600  | 1333  |
|               |                | -    | 1  | 1600                          | 1600  | 1333  |
|               | 2              | 2    | -  | 1600                          | 1333  | 1333  |
|               |                | 1    | 1  | 1333                          | 1333  | 1333  |
|               |                | -    | 2  | 1333                          | 1333  | 1333  |

1.

Population restrictions (including the order for partially populated channels) may apply. Num-DimmSlots and DimmsPopulated are per channel.

2.

Table 19: DDR3 SODIMM Maximum Frequency Support for FP3 package

| Num-DimmSlots | DimmsPopulated | DRAM |    | Frequency <sup>1</sup> (MT/s) |       |       |
|---------------|----------------|------|----|-------------------------------|-------|-------|
|               |                | SR   | DR | 1.5V                          | 1.35V | 1.25V |
| 1             | 1              | 1    | -  | 2133                          | 1866  | 1600  |
|               |                | -    | 1  | 1866                          | 1600  | 1600  |
| 2             | 1              | 1    | -  | 1600                          | 1600  | 1333  |
|               |                | -    | 1  | 1600                          | 1600  | 1333  |
|               | 2              | 2    | -  | 1600                          | 1333  | 1333  |
|               |                | 1    | 1  | 1333                          | 1333  | 1333  |
|               |                | -    | 2  | 1333                          | 1333  | 1333  |
|               |                |      |    |                               |       |       |

1. Population restrictions (including the order for partially populated channels) may apply. Num-DimmSlots and DimmsPopulated are per channel.

2.

### 2.9.3 DCT Configuration Registers

There are multiple types of DCT configuration registers:

- Registers for which there is one instance for all DCT's. E.g. [D18F2xA4](#).
- Registers for which there is one instance per DCT. E.g. [D18F2x78\\_dct\[3:0\]](#).
  - For [D18F2x78\\_dct\[x\]](#), x=[D18F1x10C\[DctCfgSel\]](#); see [D18F1x10C\[DctCfgSel\]](#).
  - The syntax for this register type is described by example as follows:
    - [D18F2x78\\_dct\[3:0\]](#) refers to all instances of the [D18F2x78](#) register.
    - [D18F2x78\\_dct\[1\]](#) refers to the [D18F2x78](#) register instance for DCT1.
- Registers for which there is one instance per NbPstate use [D18F1x10C\[NbPsSel\]](#) for software accesses.
  - [D18F2x210\\_dct\[3:0\]\\_nbp\[3:0\]](#) refers to all instances of the [D18F2x210](#) register.
  - [D18F2x210\\_dct\[3:0\]\\_nbp\[1\]](#) refers to the register for Nb P-state 1 of any or all DCTs.
- Registers for which there is one instance per memory P-state use [D18F1x10C\[MemPsSel\]](#) for software accesses. The syntax for this register type is described by example as follows:
  - [D18F2x2E8\\_dct\[3:0\]\\_mp\[1:0\]](#) refers to all instances of the [D18F2x2E8](#) register.

- D18F2x2E8\_dct[3:0]\_mp[1] refers to the register for memory P-state 1 of either or both DCTs.

In [Ddr3Mode](#), the DCT controls 64-bits of data. The phy registers of a 64-bit phy channel are programmed through a single DCT master by setting [D18F1x10C](#)[DctCfgSel] to the DCT master as shown in [Table 14](#).

## 2.9.4 DDR Pad to Processor Pin Mapping

The relationship of pad drivers to processor pins varies by package as shown in the following table.

**Table 20: Package pin mapping**

| Pad          | Pin <sup>1</sup>    |             |     |
|--------------|---------------------|-------------|-----|
|              | FS2 (not supported) | FM2r2       | FP3 |
| MEMCLK0_H[0] | MA_CLK_H[0]         |             |     |
| MEMCLK0_H[1] | MA_CLK_H[1]         |             |     |
| MEMCLK0_H[2] | NC                  | MA_CLK_H[2] |     |
| MEMCLK0_H[3] | NC                  | MA_CLK_H[3] |     |
| MEMCLK0_H[4] | NC                  |             |     |
| MEMCLK1_H[0] | MB_CLK_H[0]         |             |     |
| MEMCLK1_H[1] | MB_CLK_H[1]         |             |     |
| MEMCLK1_H[2] | NC                  | MB_CLK_H[2] |     |
| MEMCLK1_H[3] | NC                  | MB_CLK_H[3] |     |
| MEMCLK1_H[4] | NC                  |             |     |
| MEMCS0_L[0]  | MA0_CS_L[0]         |             |     |
| MEMCS0_L[1]  | MA0_CS_L[1]         |             |     |
| MEMCS0_L[2]  | NC                  | MA1_CS_L[0] |     |
| MEMCS0_L[3]  | NC                  | MA1_CS_L[1] |     |
| MEMCS0_L[4]  | NC                  |             |     |
| MEMCS0_L[5]  | NC                  |             |     |
| MEMCS0_L[6]  | NC                  |             |     |
| MEMCS0_L[7]  | NC                  |             |     |
| MEMCS1_L[0]  | MB0_CS_L[0]         |             |     |
| MEMCS1_L[1]  | MB0_CS_L[1]         |             |     |
| MEMCS1_L[2]  | NC                  | MB1_CS_L[0] |     |
| MEMCS1_L[3]  | NC                  | MB1_CS_L[1] |     |
| MEMCS1_L[4]  | NC                  |             |     |
| MEMCS1_L[5]  | NC                  |             |     |
| MEMCS1_L[6]  | NC                  |             |     |
| MEMCS1_L[7]  | NC                  |             |     |
| MEMODT0[0]   | MA0_ODT[0]          |             |     |
| MEMODT0[1]   | MA0_ODT[1]          |             |     |
| MEMODT0[2]   | NC                  | MA1_ODT[0]  |     |

**Table 20: Package pin mapping**

|                                                                                                                                                                                                                                                         |            |            |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|------------|
| MEMODT0[3]                                                                                                                                                                                                                                              | NC         | MA1_ODT[1] |
| MEMODT1[0]                                                                                                                                                                                                                                              | MB0_ODT[0] |            |
| MEMODT1[1]                                                                                                                                                                                                                                              | MB0_ODT[1] |            |
| MEMODT1[2]                                                                                                                                                                                                                                              | NC         | MB1_ODT[0] |
| MEMODT1[3]                                                                                                                                                                                                                                              | NC         | MB1_ODT[1] |
| MEMCKE0[0]                                                                                                                                                                                                                                              | MA_CKE[0]  |            |
| MEMCKE0[1]                                                                                                                                                                                                                                              | MA_CKE[1]  |            |
| MEMCKE0[2]                                                                                                                                                                                                                                              | NC         | MA_CKE[2]  |
| MEMCKE0[3]                                                                                                                                                                                                                                              | NC         | MA_CKE[3]  |
| MEMCKE1[0]                                                                                                                                                                                                                                              | MB_CKE[0]  |            |
| MEMCKE1[1]                                                                                                                                                                                                                                              | MB_CKE[1]  |            |
| MEMCKE1[2]                                                                                                                                                                                                                                              | NC         | MB_CKE[2]  |
| MEMCKE1[3]                                                                                                                                                                                                                                              | NC         | MB_CKE[3]  |
| 1. For differential pins, only positive polarity pins are shown; negative polarity pins have corresponding mapping and are controlled by the same CSR field.<br>NC = Not connected. BIOS should tri-state or disable the pad for maximum power savings. |            |            |

### 2.9.4.1 DDR Chip to Pad Mapping

The relationship of chip to pad drivers is shown in the following table. BIOS should disable or power down unused chips for maximum power savings.

**Table 21: DDR Chip to pad mapping (DDR3 Mode)**

| Chiplet | Group | Pad Number <sup>1</sup> | Pad <sup>2</sup>                                                                         |
|---------|-------|-------------------------|------------------------------------------------------------------------------------------|
| CAD 0   | 0     | 3,2,1,0                 | MEMCKE0[2], MEMCKE0[3],<br>MEMCKE0[0], MEMCKE0[1]                                        |
|         | 1     |                         | Unused                                                                                   |
|         | 2     | 11,10,9,8,<br>7,6,5,4   | MEMADD0[14,15,12],<br>MEMBANK0[2],<br>MEMADD0[8,7,11,9]                                  |
|         | 3     |                         | Unused                                                                                   |
| CAD 1   | 0     | 11,10,3,2,<br>1,0       | MEMCLK0_L[4], MEMCLK0_H[4],<br>MEMCLK0_L[2], MEMCLK0_H[2],<br>MEMCLK0_L[0], MEMCLK0_H[0] |
|         | 1     |                         | Unused                                                                                   |
|         | 2     | 9,8,7,6,5,<br>4         | MEMADD0[5,6],<br>MEMADD0[2,1,3,4]                                                        |
|         | 3     |                         | Unused                                                                                   |

Table 21: DDR Chip to pad mapping (DDR3 Mode)

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                         |           |                                                                                                  |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|-----------|--------------------------------------------------------------------------------------------------|
| CAD 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 0                       | 3,2,1,0   | MEMCLK0_L[3], MEMCLK0_H[3],<br>MEMCLK0_L[1], MEMCLK0_H[1]                                        |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 1                       | 7,6,5,4   | MEMADD0[10], MEMBANK0[0],<br>MEMADD0[0], MEMBANK0[1]                                             |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 2                       | 11,10,9,8 | MEMCS0_L[6], MEMCS0_L[4],<br>MEMCS0_L[2], MEMCS0_L[0]                                            |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 3                       |           | Unused                                                                                           |
| CAD 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 0                       | 3,2,1,0   | MEMADD0[13], MEMCAS0_L,<br>MEMWE0_L, MEMRAS0_L                                                   |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 1                       | 7,6,5,4   | MEMODT0[3], MEMODT0[1],<br>MEMODT0[0], MEMODT0[2]                                                |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 2                       | 11,10,9,8 | MEMCS0_L[7], MEMCS0_L[5],<br>MEMCS0_L[3], MEMCS0_L[1]                                            |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 3                       |           | Unused                                                                                           |
| DATA <sup>3</sup><br>[7:0]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 0                       | 3,2,1,0   | DQ[3,2,1,0]                                                                                      |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 1<br>(transmit control) | 11,10,9,8 | unused, MEMDQS_L[0] <sup>4</sup> , MEM-<br>DQSDM[0] <sup>4</sup> , MEMDQS_H[0] <sup>4</sup>      |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 1<br>(receive control)  | 11,10,9,8 | unused, (MEMDQS_L[0] <sup>4</sup> and MEM-<br>DQSDM[0] <sup>4</sup> ), unused, unused            |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 2                       | 7,6,5,4   | DQ[7,6,5,4]                                                                                      |
| DATA 8                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 0                       | 3,2,1,0   | MEMCHECK[3,2,1,0]                                                                                |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 1<br>(transmit control) | 11,10,9,8 | unused, MEMDQS_L[0] <sup>4</sup> , MEM-<br>DQSDM[0] <sup>4</sup> , MEMDQS_H[0] <sup>4</sup>      |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 1<br>(receive control)  | 11,10,9,8 | unused, (MEMCHECKDQS_L[0] <sup>4</sup><br>and MEMCHECKDQSDM[0] <sup>4</sup> ),<br>unused, unused |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 2                       | 7,6,5,4   | MEMCHECK[7,6,5,4]                                                                                |
| <p>1. Pad number is the logical address of a CSR addressable timing or impedance control.<br/> <a href="#">D18F2x9C_x00[F,3:0]0_0009_dct[3:0][HiAddrMode] = 0.</a></p> <p>2. Only channel A is shown. Channel B is similar.</p> <p>3. Pad column shows pads only for Data chip 0. Data chips [7:1] are repeated with sequential DQ/DQS/DM pin numbers.</p> <p>4. MEMDQSDM functions as DM when using unbuffered DIMMs. MEMDQS_H is the positive polarity of the “lower nibble” DQS pad used for all devices.</p> |                         |           |                                                                                                  |

### 2.9.5 DRAM Controller Direct Response Mode

The DCT supports direct response mode for responding to a cache line fill request before the DCT is initialized. In direct response mode, the target DCT responds to a cache line fill request by returning 64 bytes of all

ones without issuing a read transaction on the DRAM bus. The BIOS uses this feature to allocate cache lines for temporary data storage. The controller exits direct response mode when either [D18F2x78\\_dct\[3:0\]](#)[Chan-Val] is set to 1. See [2.3.3 \[Using L2 Cache as General Storage During Boot\]](#).

### 2.9.6 DRAM Data Burst Mapping

DRAM requests are mapped to data bursts on the DDR bus in the following order:

- When [D18F2x110](#)[DctDatIntLv] = 0, a 64 B request is mapped to each of the eight sequential data beats as QW0, QW1...QW7.
- When [D18F2x110](#)[DctDatIntLv] = 1, the order of cache data to QW on the bus is the same except that even and odd bits are interleaved on the DRAM bus as follows:
  - For every 8 bytes in the cache line, even bits map to QW0, QW2, QW4, and QW6 on the DRAM bus.
  - For every 8 bytes in the cache line, odd bits map to QW1, QW3, QW5, and QW7 on the DRAM bus.

## 2.9.7 SOC Specific Definitions

**Table 22: DCT Definitions**

| Term                    | Definition                                                             |
|-------------------------|------------------------------------------------------------------------|
| <b>GraphicsDC</b>       | Graphics downcore.                                                     |
| <b>Solder-down DRAM</b> | DRAM devices soldered directly to the motherboard.                     |
| <b>SRAMmsgBlk</b>       | SRAM message block. See <a href="#">2.9.8.3 [SRAM Message Block]</a> . |

## 2.9.8 PMU

The processor includes a phy micro-controller unit (PMU) used for training the DDR data bus during boot. BIOS communicates with the PMU using one of two methods.

- Mailbox: BIOS waits for upstream messages from the PMU for action synchronization or for status messages.
  - A 16-bit mailbox exists for upstream messages. See [2.9.8.1](#). Only the lower 8-bits are used. BIOS may safely ignore the upper 8-bits of the message.
  - A 16-bit mailbox exists for upstream data transfer. See [2.9.8.2](#).
- SRAM: BIOS may read or write the memory used by the PMU to send or receive complex message data. The PMU must be halted or in the reset state for BIOS to access PMU SRAM.

### 2.9.8.1 mboxUSPend

To wait for an upstream message BIOS does the following:

1. Wait until `D18F2x9C_x0002_0004_dct[3:0][UsRdy] == 0`.
2. Read `D18F2x9C_x0002_0032_dct[3:0][Message]`. See [Table 23](#) for a list of message names and values.
3. Program `D18F2x9C_x0002_0033_dct[3:0][Rdy] = 1`.

See [2.9.9.5](#) for related information.

**Table 23: US Mailbox 1 Messages for DDR3**

| Name         | <code>D18F2x9C_x0002_0032_dct[3:0][Message]</code> | Description                      |
|--------------|----------------------------------------------------|----------------------------------|
| DevInit      | 00h                                                | PMU has completed DevInit.       |
| TrainWrLvl   | 01h                                                | PMU has completed TSTAGE_WrLvl   |
| TrainRxEn    | 02h                                                | PMU has completed TSTAGE_RxEn    |
| TrainRdDqs1D | 03h                                                | PMU has completed TSTAGE_RdDqs1D |
| TrainWrDq1D  | 04h                                                | PMU has completed TSTAGE_WrDq1D  |
| TrainRd2D    | 05h                                                | PMU has completed TSTAGE_Rd2D    |
| TrainWr2D    | 06h                                                | PMU has completed TSTAGE_Wr2D.   |

**Table 23: US Mailbox 1 Messages for DDR3**

| Name      | D18F2x9C_x0002_0032_dct[3:0][Message] | Description                                                                                                     |
|-----------|---------------------------------------|-----------------------------------------------------------------------------------------------------------------|
| PMUQEmpty | 07h                                   | PMU has completed all of its SequenceCtl tasks and is in a power-gated idle state.                              |
| US2MsgRdy | 08h                                   | PMU is ready to stream a message through US mailbox 2.                                                          |
| FAIL      | 0FFh                                  | PMU has encountered an error which requires requester to abort waiting for remaining pending upstream messages. |

### 2.9.8.2 mboxUS2Pend

To receive a block of data through US mailbox 2, BIOS does the following:

1. Wait until [D18F2x9C\\_x0002\\_0004\\_dct\[3:0\]\[Us2Rdy\]](#)==0.
2. Read [D18F2x9C\\_x0002\\_0034\\_dct\[3:0\]\[Message\]](#). The first item received is the COUNT.
3. Program [D18F2x9C\\_x0002\\_0035\\_dct\[3:0\]\[Rdy\]](#) = 1.
4. Decrement COUNT and loop to step 1 until COUNT==1.

### 2.9.8.3 SRAM Message Block

The SRAM message block is used to pass information from BIOS to PMU and vice-versa. BIOS accesses the SRAM message block through [D18F2x9C\\_x0005\\_\[0BFF:0000\]\\_dct\[3:0\]](#).

**Table 24: SRAM Message Block for DDR3**

| Name       | Memory P-state <sup>1</sup> | Location <sup>2</sup> | Input for | Output of | Description                                                                                                                                                                        |
|------------|-----------------------------|-----------------------|-----------|-----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Revision   | -                           | 00h                   | DevInit   | -         | Table revision.                                                                                                                                                                    |
| Reserved   | -                           | 03:01h                |           | -         |                                                                                                                                                                                    |
| CpuId      | -                           | 07:04h                | DevInit   | -         | 32-bit CPUID                                                                                                                                                                       |
| DramType   | -                           | 08h                   | DevInit   | -         | Dram type from SPD byte 2 (e.g. 0Bh=DDR3)                                                                                                                                          |
| ModuleType | -                           | 09h                   | DevInit   | -         | ModuleType[6:0]=Module type from SPD byte 3 (e.g. 02h=UDIMM, 03h=SO-DIMM)<br>ModuleType[7]=PMU-train-ECC. BIOS sets to 1 if all DIMMs on the channel are ECC capable; 0 otherwise. |
| RawCard0   | -                           | 0Ah                   | DevInit   | -         | DIMM0 reference raw card from module type specific SPD location (e.g. byte 62 is used for UDIMMs)                                                                                  |
| RawCard1   | -                           | 0Bh                   | DevInit   | -         | DIMM1 reference raw card from module type specific SPD location (e.g. byte 62 is used for UDIMMs)                                                                                  |
| Reserved   |                             | 0D:0Ch                |           |           |                                                                                                                                                                                    |

**Table 24: SRAM Message Block for DDR3**

| Name          | Memory P-state <sup>1</sup> | Location <sup>2</sup> | Input for   | Output of | Description                                                                                                                                                                                                                 |
|---------------|-----------------------------|-----------------------|-------------|-----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ChipSelect    | -                           | 0Eh                   | DevInit     | -         | Specifies which chipselects are present and should be trained. Bit 0 is chip select 0, Bit 1 is chip select 1, etc.                                                                                                         |
| AddrMirror    | -                           | 0Fh                   | DevInit     | -         | For each chipselect, specifies which chipselects have address mirroring (BA0 swapped with BA1, A3 swapped with A4, A5 swapped with A6, A7 swapped with A8).                                                                 |
| Dimm0Cols     | -                           | 10h                   | DevInit     | -         | Number of device column address bits for Dimm0.                                                                                                                                                                             |
| Dimm0Banks    | -                           | 11h                   | DevInit     | -         | Number of device bank address bits for Dimm0.                                                                                                                                                                               |
| Dimm0Rows     | -                           | 12h                   | DevInit     | -         | Number of device row address bits for Dimm0.                                                                                                                                                                                |
| Dimm1Cols     | -                           | 13h                   | DevInit     | -         | Number of device column address bits for Dimm1.                                                                                                                                                                             |
| Dimm1Banks    | -                           | 14h                   | DevInit     | -         | Number of device bank address bits for Dimm1.                                                                                                                                                                               |
| Dimm1Rows     | -                           | 15h                   | DevInit     | -         | Number of device row address bits for Dimm1.                                                                                                                                                                                |
| Reserved      |                             | 1B:16h                |             |           |                                                                                                                                                                                                                             |
| TestFail      | -                           | 1Ch                   | -           | any       | Specifies which chipselects (if any) have failed training. Bit 0 is chip select 0, Bit 1 is chip select 1, etc.                                                                                                             |
| PerRankTiming | -                           | 1Dh                   | TSTAGE_RxEn | -         | 1=The channel is configured to use four timing sources for four independent chipselects. 0=The channel is configured to use four timing sources for four pairs of chipselects (logical DIMMs).                              |
| CurrentTemp   | -                           | 1F:1Eh                | DevInit     | -         |                                                                                                                                                                                                                             |
| SequenceCtl   | -                           | 21:20h                | any         | -         | PMU Sequence Control Word<br>[0] 1=DevInit<br>[1] 1=WtLvl Training<br>[2] 1=RxEnDly Training<br>[3] 1=1D Rd-Dqs Training<br>[4] 1=1D Wr-Dq Training<br>[5] 1=2D Read Training<br>[6] 1=2D Write Training<br>[15:7] Reserved |
| Reserved      | -                           | 22h                   |             |           |                                                                                                                                                                                                                             |
| CkeSetup      | 0                           | 23h                   | DevInit     | -         | Setup time on CAD bus signals. See AddrCmd-Setup for data format.                                                                                                                                                           |
| CsOdtSetup    | 0                           | 24h                   | DevInit     | -         | Setup time on CAD bus signals. See AddrCmd-Setup for data format.                                                                                                                                                           |



**Table 24: SRAM Message Block for DDR3**

| Name            | Memory P-state <sup>1</sup> | Location <sup>2</sup> | Input for | Output of   | Description                                                                                                                                                                                                                                                                                                                                        |
|-----------------|-----------------------------|-----------------------|-----------|-------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| AddrCmd-Setup   | 0                           | 25h                   | DevInit   | -           | Setup time on CAD bus signals.<br>[4:0] Fine delay, in 1/32 UI increments, relative to prelaunch.<br>[5] Prelaunch, in 1UI increments, relative to positive latching memclock edge. 1=1 memclock, 0=1/2 memclock. If the signal is in 2T timing mode then signal asserts exactly 1 memclock earlier than specified and is 2 memclocks in duration. |
| SlowAccess-Mode | 0                           | 26h                   | DevInit   | -           | 1=2T Timing is enabled in the controller (See <a href="#">D18F2x94_dct[3:0][SlowAccessMode]</a> )                                                                                                                                                                                                                                                  |
| tRP             | 0                           | 27h                   | DevInit   | -           | In units of memclocks. See <a href="#">D18F2x200_dct[3:0]_mp[1:0][Trp]</a> for definition.                                                                                                                                                                                                                                                         |
| tMRD            | 0                           | 28h                   | DevInit   | -           | In units of memclocks. See <a href="#">D18F2x220_dct[3:0][Tmrd]</a> for definition.                                                                                                                                                                                                                                                                |
| tRFC            | 0                           | 29h                   | DevInit   | -           | In units of memclocks. The maximum value for all DIMMs. See <a href="#">D18F2x208_dct[3:0][Trfc]</a> .                                                                                                                                                                                                                                             |
| MR0             | 0                           | 2B:2Ah                | DevInit   | -           |                                                                                                                                                                                                                                                                                                                                                    |
| MR1             | 0                           | 2D:2Ch                | DevInit   | -           |                                                                                                                                                                                                                                                                                                                                                    |
| MR2             | 0                           | 2F:2Eh                | DevInit   | -           |                                                                                                                                                                                                                                                                                                                                                    |
| CD_R_W          | 0                           | 30h                   | -         | TSTAGE_Wr2D | Command delay, read to write, any chip select to any other chipselect. Units are memclocks, unsigned integer.                                                                                                                                                                                                                                      |
| CD_R_R          | 0                           | 31h                   | -         | TSTAGE_Wr2D | Command delay, read to read, any chip select to any other chipselect. Units are memclocks, unsigned integer.                                                                                                                                                                                                                                       |
| CD_W_W          | 0                           | 32h                   | -         | TSTAGE_Wr2D | Command delay, write to write, any chip select to any other chipselect. Units are memclocks, unsigned integer.                                                                                                                                                                                                                                     |
| CD_W_R          | 0                           | 33h                   | -         | TSTAGE_Wr2D | Command delay, write to read, any chip select to any other chipselect. Units are memclocks, unsigned integer.                                                                                                                                                                                                                                      |
| CD_R_R_SD       | 0                           | 34h                   | -         | TSTAGE_Wr2D | Command delay, read to read, any chip select to another chipselect of same DIMM. Units are memclocks, unsigned integer.                                                                                                                                                                                                                            |
| CD_W_W_S<br>D   | 0                           | 35h                   | -         | TSTAGE_Wr2D | Command delay, write to write, any chip select to another chipselect of same DIMM. Units are memclocks, unsigned integer.                                                                                                                                                                                                                          |
| Trdrdban_Phy    | 0                           | 36h                   | -         | TSTAGE_Rd2D | In memclocks. See <a href="#">D18F2x218_dct[3:0]_mp[1:0][TrdrdBan]</a>                                                                                                                                                                                                                                                                             |
| CkeSetup        | 1                           | 37h                   | DevInit   | -           | Setup time on CAD bus signals. See AddrCmd-Setup for data format.                                                                                                                                                                                                                                                                                  |

**Table 24: SRAM Message Block for DDR3**

| Name            | Memory P-state <sup>1</sup> | Location <sup>2</sup> | Input for | Output of   | Description                                                                                                                                                                                                                                                                                                                                        |
|-----------------|-----------------------------|-----------------------|-----------|-------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CsOdtSetup      | 1                           | 38h                   | DevInit   | -           | Setup time on CAD bus signals. See AddrCmd-Setup for data format.                                                                                                                                                                                                                                                                                  |
| AddrCmd-Setup   | 1                           | 39h                   | DevInit   | -           | Setup time on CAD bus signals.<br>[4:0] Fine delay, in 1/32 UI increments, relative to prelaunch.<br>[5] Prelaunch, in 1UI increments, relative to positive latching memclock edge. 1=1 memclock, 0=1/2 memclock. If the signal is in 2T timing mode then signal asserts exactly 1 memclock earlier than specified and is 2 memclocks in duration. |
| SlowAccess-Mode | 1                           | 3Ah                   | DevInit   | -           | 1=2T Timing is enabled in the controller (See <a href="#">D18F2x94_dct[3:0][SlowAccessMode]</a> ). Note: Current DCT implementation does not support per memory P-state instances.                                                                                                                                                                 |
| tRP             | 1                           | 3Bh                   | DevInit   | -           | In units of memclocks. See <a href="#">D18F2x200_dct[3:0]_mp[1:0][Trp]</a> for definition.                                                                                                                                                                                                                                                         |
| tMRD            | 1                           | 3Ch                   | DevInit   | -           | In units of memclocks. See <a href="#">D18F2x220_dct[3:0][Tmrd]</a> for definition.                                                                                                                                                                                                                                                                |
| tRFC            | 1                           | 3Dh                   | DevInit   | -           | In units of memclocks. The maximum value for all DIMMs. See <a href="#">D18F2x208_dct[3:0][Trfc]</a> .                                                                                                                                                                                                                                             |
| MR0             | 1                           | 3F:3Eh                | DevInit   | -           |                                                                                                                                                                                                                                                                                                                                                    |
| MR1             | 1                           | 41:40h                | DevInit   | -           |                                                                                                                                                                                                                                                                                                                                                    |
| MR2             | 1                           | 43:42h                | DevInit   | -           |                                                                                                                                                                                                                                                                                                                                                    |
| CD_R_W          | 1                           | 44h                   | -         | TSTAGE_Wr2D | Command delay, read to write, any chip select to any other chipselect. Units are memclocks, unsigned integer.                                                                                                                                                                                                                                      |
| CD_R_R          | 1                           | 45h                   | -         | TSTAGE_Wr2D | Command delay, read to read, any chip select to any other chipselect. Units are memclocks, unsigned integer.                                                                                                                                                                                                                                       |
| CD_W_W          | 1                           | 46h                   | -         | TSTAGE_Wr2D | Command delay, write to write, any chip select to any other chipselect. Units are memclocks, unsigned integer.                                                                                                                                                                                                                                     |
| CD_W_R          | 1                           | 47h                   | -         | TSTAGE_Wr2D | Command delay, write to read, any chip select to any other chipselect. Units are memclocks, unsigned integer.                                                                                                                                                                                                                                      |
| CD_R_R_SD       | 1                           | 48h                   | -         | TSTAGE_Wr2D | Command delay, read to read, any chip select to another chipselect of same DIMM. Units are memclocks, unsigned integer.                                                                                                                                                                                                                            |

**Table 24: SRAM Message Block for DDR3**

| Name                                                                                                                                                                                                                                                                                                                                                        | Mem-ory P-state <sup>1</sup> | Location <sup>2</sup> | Input for | Output of       | Description                                                                                                               |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|-----------------------|-----------|-----------------|---------------------------------------------------------------------------------------------------------------------------|
| CD_W_W_S<br>D                                                                                                                                                                                                                                                                                                                                               | 1                            | 49h                   | -         | TSTAGE<br>_Wr2D | Command delay, write to write, any chip select to another chipselect of same DIMM. Units are memclocks, unsigned integer. |
| Trdrdban_Phy                                                                                                                                                                                                                                                                                                                                                | 1                            | 4Ah                   | -         | TSTAGE<br>_Rd2D | In memclocks. See <a href="#">D18F2x218_dct[3:0]_mp[1:0][TrdrdBan]</a>                                                    |
| <ol style="list-style-type: none"> <li>1. If no memory P-state is specified then the field applies to both states.</li> <li>2. Locations are byte address offsets and are relative to the start of <a href="#">D18F2x9C_x0005_[0BFF:0000]_dct[3:0]</a>. Thus to access an odd byte, software accesses the upper 8-bits of the even word-address.</li> </ol> |                              |                       |           |                 |                                                                                                                           |

### 2.9.9 DCT/DRAM Initialization and Resume

DRAM initialization involves several steps in order to configure the DRAM controllers and the DRAM, and to tune the DRAM channel for optimal performance. DRAM resume requires several steps to configure the DCTs to properly resume from the S3 state. The following sequence describes the steps needed after a reset for initialization or resume:

- To disable an unused DRAM channel see [2.9.9.8](#).
1. Configure the DDR supply voltage regulator. See [2.9.9.1](#).
  2. NB P-state specific initialization.
    - A. Program the DCT configuration registers which contain multiple internal copies for each NB P-state. See [D18F1x10C\[NbPsSel\]](#).
    - B. Force NB P-state to NBP0. See [2.5.4.1.3.2](#)
  3. DDR phy initialization. See [2.9.9.2](#).
  4. If BIOS is booting from an unpowered state (ACPI S4, S5 or G3), then it performs the following:
    - A. Program DRAM controller general configuration, for both memory P-states. See [2.9.9.3](#).
    - B. Program DCT specific configuration for training, for both memory P-states. See [2.9.9.4](#).
    - C. Program the remaining DCT registers not covered by an explicit sequence dependency.
    - D. Program [D18F2x9C\\_x0002\\_0060\\_dct\[3:0\]\[MemReset\\_L\]](#)=0.
    - E. Program [D18F2x9C\\_x0002\\_000B\\_dct\[3:0\]](#)=0004h.
    - F. Program [D18F2x9C\\_x0002\\_000B\\_dct\[3:0\]](#)=0000h.
    - G. Perform DRAM device initialization and data training. See [2.9.9.5](#).
    - H. Enable phy auto-calibration. See [2.9.9.2.8.3](#).
    - I. Synchronous channel initialization. See [2.9.9.7](#).
    - J. Program [D18F2x90\\_dct\[3:0\]\[ExitSelfRef\]](#)=1. Wait for [D18F2x90\\_dct\[3:0\]\[ExitSelfRef\]](#)==0. Wait  $T_{ref} \times 2$ .
    - K. Program [D18F2x78\\_dct\[3:0\]\[ChanVal\]](#)=1.
    - L. NB P-state specific training. For each NB P-state from NBP0 to [D18F5x170\[NbPstateMaxVal\]](#):
      - a. Force the NB P-state. See [2.5.4.1.3.2](#).
      - b. MaxRdLatency training. See [2.9.9.6.1](#).
    - M. Program DCT specific configuration for normal operation, for both memory P-states. See [2.9.9.4](#).
    - N. Program DRAM phy for power savings. See [2.9.9.9](#).
  5. If BIOS is resuming the platform from S3 state, then it performs the following:
    - A. Restore all DCT and phy registers that were programmed during the first boot from non-volatile storage. See [2.9.9.3](#), [2.9.9.4](#), and [2.9.9.9](#) for a review of registers.
    - B. Restore the trained delayed values from nonvolatile storage. See [2.9.9.2.10](#).
    - C. Program [D18F2x9C\\_x0002\\_0060\\_dct\[3:0\]\[MemReset\\_L\]](#)=1.
    - D. Program [D18F2x9C\\_x0002\\_000B\\_dct\[3:0\]](#)=0004h.
    - E. Program [D18F2x9C\\_x0002\\_000B\\_dct\[3:0\]](#)=0000h.
    - F. Fence the CalOnce. See [2.9.9.2.8.2](#).
    - G. Enable phy auto-calibration. See [2.9.9.2.8.3](#).
    - H. Synchronous channel initialization. See [2.9.9.7](#).
    - I. Program [D18F2x90\\_dct\[3:0\]\[ExitSelfRef\]](#)=1. Wait for [D18F2x90\\_dct\[3:0\]\[ExitSelfRef\]](#)==0
    - J. Program [D18F2x78\\_dct\[3:0\]\[ChanVal\]](#)=1.
  6. Release NB P-state force. See [2.5.4.1.3.2](#).

The DRAM subsystem is ready for use.

### 2.9.9.1 Low Voltage

For DDR3 devices, the processor supports JEDEC defined 1.5V, 1.35V and 1.25V devices

Platforms supporting low voltage devices should power up VDDIO at 1.35V. BIOS should not operate DIMMs at voltages higher than supported. For DDR3 this is indicated by SPD Byte 6: Module Nominal Voltage, VDD.

BIOS should consult vendor data sheets for the supply voltage regulator programming requirements. On supported platforms, BIOS must take steps to configure the supply voltage regulators as follows:

1. Read the [SPD](#) of all devices within the programmable VDDIO domain and check all of the defined bits within the SPD byte to determine the common operating voltages.
2. Configure VDDIO to match the lowest common supported voltage based on the SPD values.
  - If the DIMMs do not specify a common operating voltage then BIOS must take platform vendor defined action to notify the end user of the mismatch and to protect DIMMs from damage.
3. Additional derating of the DDR speed may be necessary for reliable operation at lower voltage.

### 2.9.9.2 DDR Phy Initialization

The BIOS initializes the phy and the internal interface from the DCT to the phy, after each reset and for each time a MEMCLK frequency change is made.

BIOS obtains size, loading, and frequency information about the DIMMs and channels using SPDs prior to phy initialization. BIOS then performs the following actions:

1. Program [D18F2x9C\\_x0002\\_0099\\_dct\[3:0\]\[PmuReset,PmuStall\]](#) = 1,1.
2. Program [D18F2x9C\\_x0002\\_000E\\_dct\[3:0\]\[PhyDisable\]](#)=0.
3. According to the type of DRAM attached, program the following:
  - Program [D18F2x9C\\_x00FF\\_F04A\\_dct\[3:0\]](#) = {000000h,0b,MajorMode,0h}. This is a “super-broadcast” to all instances. See:
    - [D18F2x9C\\_x00\[F,3:0\]0\\_\[F,B:0\]04A\\_dct\[3:0\]\[MajorMode\]](#)
    - [D18F2x9C\\_x00\[F,8:0\]1\\_\[F,B:0\]04A\\_dct\[3:0\]\[MajorMode\]](#)
    - [D18F2x9C\\_x0009\\_004A\\_dct\[3:0\]\[MajorMode\]](#)
  - [D18F2x9C\\_x00\[F,8:0\]1\\_\[F,B:0\]05F\\_dct\[3:0\]\[G5Mode\]](#) This register is optimally programmed during data bus driver configuration in [2.9.9.2.5](#) instead of at this time.
  - [D18F2x9C\\_x0002\\_000E\\_dct\[3:0\]\[G5\\_Mode\]](#)
  - [D18F2x9C\\_x0002\\_0098\\_dct\[3:0\]\[CalG5D3\]](#).
4. Program general phy static configuration. See [2.9.9.2.1](#).
5. Phy Voltage Level Programming. See [2.9.9.2.2](#).
6. Program auto-calibration. See [2.9.9.2.8](#).
7. Program DRAM channel frequency. See [2.9.9.2.3](#).
8. Program default CAD bus values. See [2.9.9.2.4](#).
9. Program default data bus values. See [2.9.9.2.5](#).
10. Program FIFO pointer init values. See [2.9.9.2.6](#).
11. Program predriver values. See [2.9.9.2.7](#).
12. Program [D18F2x9C\\_x0002\\_0033\\_dct\[3:0\]\[Rdy\]](#) = 1.
13. Program [D18F2x9C\\_x0002\\_0035\\_dct\[3:0\]\[Rdy\]](#) = 1.

#### 2.9.9.2.1 Phy General Configuration

BIOS programs the following according to the static configuration:

- Program D18F2x9C\_x01F1\_F045\_dct[3:0]=0040h.
  - See D18F2x9C\_x0[3,1:0][F,8:0]1\_[F,7:0]045\_dct[3:0].
- If Ddr3Mode program D18F2x9C\_x00F4\_00E[7:0]\_dct[3:0].
- Program D18F2x9C\_x00F0\_0015\_dct[3:0][VrefFilt], D18F2x9C\_x00F1\_0015\_dct[3:0][VrefFilt], D18F2x9C\_x00F2\_0015\_dct[3:0][VrefFilt].
- Program D18F2x9C\_x00[F,8:0]1\_0016\_dct[3:0].

BIOS programs the following for maximum power savings prior to training:

- Program D18F2x9C\_x03F6\_F04E\_dct[] = 0B00h.
  - See D18F2x9C\_x00[F,3:0]0\_[F,B:0]04E\_dct[3:0] and D18F2x9C\_x00[F,8:0]1\_[F,B:0]04E\_dct[3:0].
- Program D18F2x9C\_x00F0\_001A\_dct[] (undocumented) = 0022h.
- Program D18F2x9C\_x00F1\_001A\_dct[] (undocumented) = 0033h.
- Program D18F2x9C\_x0002\_001A\_dct[] (undocumented) = 0001h.
- Program D18F2x9C\_x0002\_005B\_dct[3:0] = 0001h.
- Program D18F2x9C\_x00F1\_F051\_dct[] = 0152h.
  - See D18F2x9C\_x00[F,8:0]1\_[F,B:0]051\_dct[3:0].

### 2.9.9.2.2 Phy Voltage Level Programming

BIOS programs the following according to the desired phy VDDIO voltage level:

1. Program D18F2x9C\_x0002\_0098\_dct[3:0][CalCmptrResTrim].

See 2.9.9.1 [Low Voltage].

### 2.9.9.2.3 DRAM Channel Frequency

BIOS programs the DCT and the phy according to the data rate. BIOS must ensure that the DCT and the phy operate at a matched rate prior to normal operations. See D18F2x94\_dct[3:0][MemClkFreq], D18F2x2E0\_dct[3:0][M1MemClkFreq].

To program a new rate in the phy:

1. Program D18F2x9C\_x0002\_0093\_dct[3:0][PllRegWaitTime] = 04Bh.
2. Program D18F2x9C\_x0002\_0089\_dct[3:0][PllLockTime] = 190h.
3. Program D18F2x9C\_x0002\_0000\_dct[3:0][PllMultDiv].
4. Program D18F2x9C\_x0002\_0080\_dct[3:0][PMUClkDiv].
  - See D18F2x9C\_x0[1:0]02\_0080\_dct[3:0].
5. Program D18F2x9C\_x0002\_0001\_dct[3:0][PllMultDiv] = '667 MT/s'.
6. Program D18F2x9C\_x0102\_0080\_dct[3:0][PMUClkDiv].
  - See D18F2x9C\_x0[1:0]02\_0080\_dct[3:0].

The new settings will take effect after BIOS or the DCT requests a memory P-state change request via D18F2x9C\_x0002\_000B\_dct[3:0]. See 2.9.9 [DCT/DRAM Initialization and Resume].

### 2.9.9.2.4 DRAM CAD Bus Configuration

This section describes the settings required for programming the timing and drive settings on the command and address pins. The following tables document the CAD bus values on a per channel basis. DIMM0 is the DIMM closest to the processor on that channel and DIMM1 is the DIMM farthest from the processor on that channel. DIMMs must be populated from farthest slot to closest slot to the processor on a per channel basis (when a daisy chain topology is used). Populations that are not shown in these tables are not supported. These tables document the optimal settings for motherboards which meet the relevant motherboard design guidelines.

- Only the value for a single control unit register is described. The values in the tables should be broadcast to all instances of registers of the same control unit type, unless otherwise noted.

Table 25: BIOS Recommendations for DDR3 SO-DIMM CAD bus configuration

| Condition              |                   |                 |                 |                 | D18F2x94_dc[3:0]<br>[SlowAccessMode] | {000000000b<br>,AddrCmd-<br>Setup[5:0],00b<br>,CsOdt-<br>Setup[5:0],<br>00b, Cke-<br>Setup[5:0]} | D18F2x9C_x0[3,1:0][F,3:0]0_[F,B:0]041_dc[3:0]<br>[DrvStrenN] <sup>2</sup> for CKE | D18F2x9C_x0[3,1:0][F,3:0]0_[F,B:0]041_dc[3:0]<br>[DrvStrenN] <sup>2</sup> for CS and ODT | D18F2x9C_x0[3,1:0][F,3:0]0_[F,B:0]041_dc[3:0]<br>[DrvStrenN] <sup>2</sup> for AddrCmd | D18F2x9C_x0[3,1:0][F,3:0]0_[F,B:0]041_dc[3:0]<br>[DrvStrenN] <sup>2</sup> for CLK |
|------------------------|-------------------|-----------------|-----------------|-----------------|--------------------------------------|--------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|
| Condition:NumDimmSlots | Condition:DdrRate | Condition:VDDIO | Condition:DIMM0 | Condition:DIMM1 |                                      |                                                                                                  |                                                                                   |                                                                                          |                                                                                       |                                                                                   |
| 1                      | 667               | 1.25, 1.35, 1.5 | SR              | -               | 0                                    | 00000000h                                                                                        | 1Fh                                                                               | 1Fh                                                                                      | 1Fh                                                                                   | 1Fh                                                                               |
| 1                      | 667               | 1.25, 1.35, 1.5 | DR              | -               | 0                                    | 003B0000h                                                                                        | 1Fh                                                                               | 1Fh                                                                                      | 1Fh                                                                                   | 1Fh                                                                               |
| 1                      | 800               | 1.25, 1.35, 1.5 | SR              | -               | 0                                    | 00000000h                                                                                        | 1Fh                                                                               | 1Fh                                                                                      | 1Fh                                                                                   | 1Fh                                                                               |
| 1                      | 800               | 1.25, 1.35, 1.5 | DR              | -               | 0                                    | 003B0000h                                                                                        | 1Fh                                                                               | 1Fh                                                                                      | 1Fh                                                                                   | 1Fh                                                                               |
| 1                      | 1066              | 1.25, 1.35, 1.5 | SR              | -               | 0                                    | 00000000h                                                                                        | 1Fh                                                                               | 1Fh                                                                                      | 1Fh                                                                                   | 1Fh                                                                               |
| 1                      | 1066              | 1.25, 1.35, 1.5 | DR              | -               | 0                                    | 00380000h                                                                                        | 1Fh                                                                               | 1Fh                                                                                      | 1Fh                                                                                   | 1Fh                                                                               |
| 1                      | 1333              | 1.25, 1.35, 1.5 | SR              | -               | 0                                    | 00000000h                                                                                        | 1Fh                                                                               | 1Fh                                                                                      | 1Fh                                                                                   | 1Fh                                                                               |
| 1                      | 1333              | 1.25, 1.35, 1.5 | DR              | -               | 0                                    | 00360000h                                                                                        | 1Fh                                                                               | 1Fh                                                                                      | 1Fh                                                                                   | 1Fh                                                                               |
| 1                      | 1600              | 1.25, 1.35, 1.5 | SR              | -               | 0                                    | 00000000h                                                                                        | 1Fh                                                                               | 1Fh                                                                                      | 1Fh                                                                                   | 1Fh                                                                               |
| 1                      | 1600              | 1.25, 1.35, 1.5 | DR              | -               | 1                                    | 00000000h                                                                                        | 1Fh                                                                               | 1Fh                                                                                      | 1Fh                                                                                   | 1Fh                                                                               |
| 1                      | 1866              | 1.35, 1.5       | SR              | -               | 0                                    | 00000000h                                                                                        | 1Fh                                                                               | 1Fh                                                                                      | 1Fh                                                                                   | 1Fh                                                                               |
| 1                      | 1866              | 1.35, 1.5       | DR              | -               | 1                                    | 00000000h                                                                                        | 1Fh                                                                               | 1Fh                                                                                      | 1Fh                                                                                   | 1Fh                                                                               |
| 1                      | 2133              | 1.5             | SR              | -               | 0                                    | 00000000h                                                                                        | 1Fh                                                                               | 1Fh                                                                                      | 1Fh                                                                                   | 1Fh                                                                               |
| 1                      | 2133              | 1.5             | DR              | -               | 1                                    | 00000000h                                                                                        | 1Fh                                                                               | 1Fh                                                                                      | 1Fh                                                                                   | 1Fh                                                                               |
| 2                      | 667               | 1.25, 1.35, 1.5 | NP              | SR              | 0                                    | 00000000h                                                                                        | 1Fh                                                                               | 1Fh                                                                                      | 1Fh                                                                                   | 1Fh                                                                               |
| 2                      | 667               | 1.25, 1.35, 1.5 | NP              | DR              | 0                                    | 003B0000h                                                                                        | 1Fh                                                                               | 1Fh                                                                                      | 1Fh                                                                                   | 1Fh                                                                               |

Table 25: BIOS Recommendations for DDR3 SO-DIMM CAD bus configuration

| Condition              |                   |                 |                  |                  | D18F2x94_dct[3:0]<br>[SlowAccessMode] | {0000000000b<br>,AddrCmd-<br>Setup[5:0],00b<br>,CsOdt-<br>Setup[5:0],<br>00b, Cke-<br>Setup[5:0]} | D18F2x9C_x0[3:1:0][F,3:0]0_[F,B:0]041_dct[3:0]<br>[DrvStrenN] <sup>2</sup> for CKE | D18F2x9C_x0[3:1:0][F,3:0]0_[F,B:0]041_dct[3:0]<br>[DrvStrenN] <sup>2</sup> for CS and ODT | D18F2x9C_x0[3:1:0][F,3:0]0_[F,B:0]041_dct[3:0]<br>[DrvStrenN] <sup>2</sup> for AddrCmd | D18F2x9C_x0[3:1:0][F,3:0]0_[F,B:0]041_dct[3:0]<br>[DrvStrenN] <sup>2</sup> for CLK | D18F2x9C_x0[3:1:0][F,3:0]0_[F,B:0]041_dct[3:0]<br>[DrvStrenN] <sup>2</sup> for CS and ODT |
|------------------------|-------------------|-----------------|------------------|------------------|---------------------------------------|---------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|
| Condition:NumDimmSlots | Condition:DdrRate | Condition:VDDIO | Condition:DI MM0 | Condition:DI MM1 |                                       |                                                                                                   |                                                                                    |                                                                                           |                                                                                        |                                                                                    |                                                                                           |
| 2                      | 667               | 1.25, 1.35, 1.5 | SR               | SR               | 0                                     | 00390039h                                                                                         | 1Fh                                                                                | 1Fh                                                                                       | 3Fh                                                                                    | 1Fh                                                                                |                                                                                           |
| 2                      | 667               | 1.25, 1.35, 1.5 | DR               | DR               | 0                                     | 00390039h                                                                                         | 1Fh                                                                                | 1Fh                                                                                       | 3Fh                                                                                    | 1Fh                                                                                |                                                                                           |
| 2                      | 667               | 1.25, 1.35, 1.5 | DR               | SR               | 0                                     | 00390039h                                                                                         | 1Fh                                                                                | 1Fh                                                                                       | 3Fh                                                                                    | 1Fh                                                                                |                                                                                           |
| 2                      | 667               | 1.25, 1.35, 1.5 | SR               | DR               | 0                                     | 00390039h                                                                                         | 1Fh                                                                                | 1Fh                                                                                       | 3Fh                                                                                    | 1Fh                                                                                |                                                                                           |
| 2                      | 800               | 1.25, 1.35, 1.5 | NP               | SR               | 0                                     | 00000000h                                                                                         | 1Fh                                                                                | 1Fh                                                                                       | 1Fh                                                                                    | 1Fh                                                                                |                                                                                           |
| 2                      | 800               | 1.25, 1.35, 1.5 | NP               | DR               | 0                                     | 003B0000h                                                                                         | 1Fh                                                                                | 1Fh                                                                                       | 1Fh                                                                                    | 1Fh                                                                                |                                                                                           |
| 2                      | 800               | 1.25, 1.35, 1.5 | SR               | SR               | 0                                     | 00390039h                                                                                         | 1Fh                                                                                | 1Fh                                                                                       | 3Fh                                                                                    | 1Fh                                                                                |                                                                                           |
| 2                      | 800               | 1.25, 1.35, 1.5 | DR               | DR               | 0                                     | 00390039h                                                                                         | 1Fh                                                                                | 1Fh                                                                                       | 3Fh                                                                                    | 1Fh                                                                                |                                                                                           |
| 2                      | 800               | 1.25, 1.35, 1.5 | DR               | SR               | 0                                     | 00390039h                                                                                         | 1Fh                                                                                | 1Fh                                                                                       | 3Fh                                                                                    | 1Fh                                                                                |                                                                                           |
| 2                      | 800               | 1.25, 1.35, 1.5 | SR               | DR               | 0                                     | 00390039h                                                                                         | 1Fh                                                                                | 1Fh                                                                                       | 3Fh                                                                                    | 1Fh                                                                                |                                                                                           |
| 2                      | 1066              | 1.25, 1.35, 1.5 | NP               | SR               | 0                                     | 00000000h                                                                                         | 1Fh                                                                                | 1Fh                                                                                       | 1Fh                                                                                    | 1Fh                                                                                |                                                                                           |
| 2                      | 1066              | 1.25, 1.35, 1.5 | NP               | DR               | 0                                     | 00380000h                                                                                         | 1Fh                                                                                | 1Fh                                                                                       | 1Fh                                                                                    | 1Fh                                                                                |                                                                                           |
| 2                      | 1066              | 1.25, 1.35, 1.5 | SR               | SR               | 0                                     | 00350037h                                                                                         | 1Fh                                                                                | 1Fh                                                                                       | 3Fh                                                                                    | 1Fh                                                                                |                                                                                           |
| 2                      | 1066              | 1.25, 1.35, 1.5 | DR               | DR               | 0                                     | 00350037h                                                                                         | 1Fh                                                                                | 1Fh                                                                                       | 3Fh                                                                                    | 1Fh                                                                                |                                                                                           |
| 2                      | 1066              | 1.25, 1.35, 1.5 | DR               | SR               | 0                                     | 00350037h                                                                                         | 1Fh                                                                                | 1Fh                                                                                       | 3Fh                                                                                    | 1Fh                                                                                |                                                                                           |
| 2                      | 1066              | 1.25, 1.35, 1.5 | SR               | DR               | 0                                     | 00350037h                                                                                         | 1Fh                                                                                | 1Fh                                                                                       | 3Fh                                                                                    | 1Fh                                                                                |                                                                                           |
| 2                      | 1333              | 1.25, 1.35, 1.5 | NP               | SR               | 0                                     | 00000000h                                                                                         | 1Fh                                                                                | 1Fh                                                                                       | 1Fh                                                                                    | 1Fh                                                                                |                                                                                           |
| 2                      | 1333              | 1.25, 1.35, 1.5 | NP               | DR               | 0                                     | 00360000h                                                                                         | 1Fh                                                                                | 1Fh                                                                                       | 1Fh                                                                                    | 1Fh                                                                                |                                                                                           |
| 2                      | 1333              | 1.25, 1.35, 1.5 | SR               | SR               | 1                                     | 00000035h                                                                                         | 1Fh                                                                                | 1Fh                                                                                       | 3Fh                                                                                    | 1Fh                                                                                |                                                                                           |
| 2                      | 1333              | 1.25, 1.35, 1.5 | DR               | DR               | 1                                     | 00000035h                                                                                         | 1Fh                                                                                | 1Fh                                                                                       | 3Fh                                                                                    | 1Fh                                                                                |                                                                                           |
| 2                      | 1333              | 1.25, 1.35, 1.5 | DR               | SR               | 1                                     | 00000035h                                                                                         | 1Fh                                                                                | 1Fh                                                                                       | 3Fh                                                                                    | 1Fh                                                                                |                                                                                           |
| 2                      | 1333              | 1.25, 1.35, 1.5 | SR               | DR               | 1                                     | 00000035h                                                                                         | 1Fh                                                                                | 1Fh                                                                                       | 3Fh                                                                                    | 1Fh                                                                                |                                                                                           |
| 2                      | 1600              | 1.25, 1.35, 1.5 | NP               | SR               | 0                                     | 00000000h                                                                                         | 1Fh                                                                                | 1Fh                                                                                       | 1Fh                                                                                    | 1Fh                                                                                |                                                                                           |
| 2                      | 1600              | 1.25, 1.35, 1.5 | NP               | DR               | 1                                     | 00000000h                                                                                         | 1Fh                                                                                | 1Fh                                                                                       | 1Fh                                                                                    | 1Fh                                                                                |                                                                                           |
| 2                      | 1600              | 1.35, 1.5       | SR               | SR               | 1                                     | 0000002Bh                                                                                         | 1Fh                                                                                | 1Fh                                                                                       | 3Fh                                                                                    | 1Fh                                                                                |                                                                                           |
| 2                      | 1600              | 1.35, 1.5       | DR               | DR               | 1                                     | 0000002Bh                                                                                         | 1Fh                                                                                | 1Fh                                                                                       | 3Fh                                                                                    | 1Fh                                                                                |                                                                                           |



Table 25: BIOS Recommendations for DDR3 SO-DIMM CAD bus configuration

| Condition                                                                                                                                                                                                                               |                   |                 |                 |                 | D18F2x94_dec[3:0]<br>[SlowAccessMode] | {0000000000b<br>,AddrCmd-<br>Setup[5:0],00b<br>,CsOdt-<br>Setup[5:0],<br>00b, Cke-<br>Setup[5:0]} | D18F2x9C_x0[3:1:0][F,3:0]0_[F,B:0]041_dec[3:0]<br>[DrvStrenN] <sup>2</sup> for CKE | D18F2x9C_x0[3:1:0][F,3:0]0_[F,B:0]041_dec[3:0]<br>[DrvStrenN] <sup>2</sup> for CS and ODT | D18F2x9C_x0[3:1:0][F,3:0]0_[F,B:0]041_dec[3:0]<br>[DrvStrenN] <sup>2</sup> for AddrCmd | D18F2x9C_x0[3:1:0][F,3:0]0_[F,B:0]041_dec[3:0]<br>[DrvStrenN] <sup>2</sup> for CLK |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|-----------------|-----------------|-----------------|---------------------------------------|---------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|
| Condition:NumDimmSlots                                                                                                                                                                                                                  | Condition:DdrRate | Condition:VDDIO | Condition:DIMM0 | Condition:DIMM1 |                                       |                                                                                                   |                                                                                    |                                                                                           |                                                                                        |                                                                                    |
| 2                                                                                                                                                                                                                                       | 1600              | 1.35, 1.5       | DR              | SR              | 1                                     | 0000002Bh                                                                                         | 1Fh                                                                                | 1Fh                                                                                       | 3Fh                                                                                    | 1Fh                                                                                |
| 2                                                                                                                                                                                                                                       | 1600              | 1.35, 1.5       | SR              | DR              | 1                                     | 0000002Bh                                                                                         | 1Fh                                                                                | 1Fh                                                                                       | 3Fh                                                                                    | 1Fh                                                                                |
| 2                                                                                                                                                                                                                                       | 1866              | 1.35, 1.5       | NP              | SR              | 0                                     | 003C3C3Ch                                                                                         | 1Fh                                                                                | 1Fh                                                                                       | 1Fh                                                                                    | 1Fh                                                                                |
| 2                                                                                                                                                                                                                                       | 1866              | 1.35, 1.5       | NP              | DR              | 1                                     | 00003C3Ch                                                                                         | 1Fh                                                                                | 1Fh                                                                                       | 1Fh                                                                                    | 1Fh                                                                                |
| 2                                                                                                                                                                                                                                       | 1866              | 1.5             | SR              | SR              | 1                                     | 00000031h                                                                                         | 1Fh                                                                                | 1Fh                                                                                       | 3Fh                                                                                    | 1Fh                                                                                |
| 2                                                                                                                                                                                                                                       | 1866              | 1.5             | DR              | DR              | 1                                     | 00000031h                                                                                         | 1Fh                                                                                | 1Fh                                                                                       | 3Fh                                                                                    | 1Fh                                                                                |
| 2                                                                                                                                                                                                                                       | 1866              | 1.5             | DR              | SR              | 1                                     | 00000031h                                                                                         | 1Fh                                                                                | 1Fh                                                                                       | 3Fh                                                                                    | 1Fh                                                                                |
| 2                                                                                                                                                                                                                                       | 1866              | 1.5             | SR              | DR              | 1                                     | 00000031h                                                                                         | 1Fh                                                                                | 1Fh                                                                                       | 3Fh                                                                                    | 1Fh                                                                                |
| 2                                                                                                                                                                                                                                       | 2133              | 1.5             | NP              | SR              | 0                                     | 003B3B3Bh                                                                                         | 1Fh                                                                                | 1Fh                                                                                       | 1Fh                                                                                    | 1Fh                                                                                |
| 2                                                                                                                                                                                                                                       | 2133              | 1.5             | NP              | DR              | 1                                     | 00003B3Bh                                                                                         | 1Fh                                                                                | 1Fh                                                                                       | 1Fh                                                                                    | 1Fh                                                                                |
| <ol style="list-style-type: none"> <li>BIOS writes the values for AddrCmdSetup, CsOdtSetup, and CkeSetup into the <b>SRAMMsgBlk</b> for each memory P-state.</li> <li>BIOS programs DrvStrenP = DrvStrenN for each instance.</li> </ol> |                   |                 |                 |                 |                                       |                                                                                                   |                                                                                    |                                                                                           |                                                                                        |                                                                                    |

Table 26: BIOS Recommendations for DDR3 UDIMM CAD bus configuration

| Condition                           |                       |                 |                     |                     | D18F2x94_dct[3:0]<br>[SlowAccessMode] | {0000000000b<br>,AddrCmd-<br>Setup[5:0],00b<br>,CsOdt-<br>Setup[5:0],<br>00b,Cke-<br>Setup[5:0]} | D18F2x9C_x0[3:1:0][F,3:0]0_[F,B:0]041_dct[3:0]<br>[DrvStrenN] <sup>2</sup> for CKE | D18F2x9C_x0[3:1:0][F,3:0]0_[F,B:0]041_dct[3:0]<br>[DrvStrenN] <sup>2</sup> for CS and ODT | D18F2x9C_x0[3:1:0][F,3:0]0_[F,B:0]041_dct[3:0]<br>[DrvStrenN] <sup>2</sup> for AddrCmd | D18F2x9C_x0[3:1:0][F,3:0]0_[F,B:0]041_dct[3:0]<br>[DrvStrenN] <sup>2</sup> for CLK |
|-------------------------------------|-----------------------|-----------------|---------------------|---------------------|---------------------------------------|--------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|
| Condition:N<br>umDi<br>mmS-<br>lots | Condition:Ddr<br>Rate | Condition:VDDIO | Condition:DI<br>MM0 | Condition:DI<br>MM1 |                                       |                                                                                                  |                                                                                    |                                                                                           |                                                                                        |                                                                                    |
| 1                                   | 667                   | 1.25, 1.35, 1.5 | SR                  | -                   | 0                                     | 00000000h                                                                                        | 1Fh                                                                                | 1Fh                                                                                       | 1Fh                                                                                    | 1Fh                                                                                |
| 1                                   | 667                   | 1.25, 1.35, 1.5 | DR                  | -                   | 0                                     | 003B0000h                                                                                        | 1Fh                                                                                | 1Fh                                                                                       | 1Fh                                                                                    | 1Fh                                                                                |
| 1                                   | 800                   | 1.25, 1.35, 1.5 | SR                  | -                   | 0                                     | 00000000h                                                                                        | 1Fh                                                                                | 1Fh                                                                                       | 1Fh                                                                                    | 1Fh                                                                                |
| 1                                   | 800                   | 1.25, 1.35, 1.5 | DR                  | -                   | 0                                     | 003B0000h                                                                                        | 1Fh                                                                                | 1Fh                                                                                       | 1Fh                                                                                    | 1Fh                                                                                |
| 1                                   | 1066                  | 1.25, 1.35, 1.5 | SR                  | -                   | 0                                     | 00000000h                                                                                        | 1Fh                                                                                | 1Fh                                                                                       | 1Fh                                                                                    | 1Fh                                                                                |
| 1                                   | 1066                  | 1.25, 1.35, 1.5 | DR                  | -                   | 0                                     | 00380000h                                                                                        | 1Fh                                                                                | 1Fh                                                                                       | 1Fh                                                                                    | 1Fh                                                                                |
| 1                                   | 1333                  | 1.25, 1.35, 1.5 | SR                  | -                   | 0                                     | 00000000h                                                                                        | 1Fh                                                                                | 1Fh                                                                                       | 1Fh                                                                                    | 1Fh                                                                                |
| 1                                   | 1333                  | 1.25, 1.35, 1.5 | DR                  | -                   | 0                                     | 00360000h                                                                                        | 1Fh                                                                                | 1Fh                                                                                       | 1Fh                                                                                    | 1Fh                                                                                |
| 1                                   | 1600                  | 1.25, 1.35, 1.5 | SR                  | -                   | 0                                     | 00000000h                                                                                        | 1Fh                                                                                | 1Fh                                                                                       | 1Fh                                                                                    | 1Fh                                                                                |
| 1                                   | 1600                  | 1.25, 1.35, 1.5 | DR                  | -                   | 1                                     | 00000000h                                                                                        | 1Fh                                                                                | 1Fh                                                                                       | 1Fh                                                                                    | 1Fh                                                                                |
| 1                                   | 1866                  | 1.35, 1.5       | SR                  | -                   | 0                                     | 00000000h                                                                                        | 1Fh                                                                                | 1Fh                                                                                       | 1Fh                                                                                    | 1Fh                                                                                |
| 1                                   | 1866                  | 1.35, 1.5       | DR                  | -                   | 1                                     | 00000000h                                                                                        | 1Fh                                                                                | 1Fh                                                                                       | 1Fh                                                                                    | 1Fh                                                                                |
| 1                                   | 2133                  | 1.5             | SR                  | -                   | 0                                     | 00000000h                                                                                        | 1Fh                                                                                | 1Fh                                                                                       | 1Fh                                                                                    | 1Fh                                                                                |
| 1                                   | 2133                  | 1.5             | DR                  | -                   | 1                                     | 00000000h                                                                                        | 1Fh                                                                                | 1Fh                                                                                       | 1Fh                                                                                    | 1Fh                                                                                |
| 2                                   | 667                   | 1.25, 1.35, 1.5 | NP                  | SR                  | 0                                     | 00000000h                                                                                        | 1Fh                                                                                | 1Fh                                                                                       | 1Fh                                                                                    | 1Fh                                                                                |
| 2                                   | 667                   | 1.25, 1.35, 1.5 | NP                  | DR                  | 0                                     | 003B0000h                                                                                        | 1Fh                                                                                | 1Fh                                                                                       | 1Fh                                                                                    | 1Fh                                                                                |
| 2                                   | 667                   | 1.25, 1.35, 1.5 | SR                  | SR                  | 0                                     | 00390039h                                                                                        | 1Fh                                                                                | 1Fh                                                                                       | 3Fh                                                                                    | 1Fh                                                                                |
| 2                                   | 667                   | 1.25, 1.35, 1.5 | DR                  | DR                  | 0                                     | 00390039h                                                                                        | 1Fh                                                                                | 1Fh                                                                                       | 3Fh                                                                                    | 1Fh                                                                                |
| 2                                   | 667                   | 1.25, 1.35, 1.5 | DR                  | SR                  | 0                                     | 00390039h                                                                                        | 1Fh                                                                                | 1Fh                                                                                       | 3Fh                                                                                    | 1Fh                                                                                |
| 2                                   | 667                   | 1.25, 1.35, 1.5 | SR                  | DR                  | 0                                     | 00390039h                                                                                        | 1Fh                                                                                | 1Fh                                                                                       | 3Fh                                                                                    | 1Fh                                                                                |
| 2                                   | 800                   | 1.25, 1.35, 1.5 | NP                  | SR                  | 0                                     | 00000000h                                                                                        | 1Fh                                                                                | 1Fh                                                                                       | 1Fh                                                                                    | 1Fh                                                                                |
| 2                                   | 800                   | 1.25, 1.35, 1.5 | NP                  | DR                  | 0                                     | 003B0000h                                                                                        | 1Fh                                                                                | 1Fh                                                                                       | 1Fh                                                                                    | 1Fh                                                                                |
| 2                                   | 800                   | 1.25, 1.35, 1.5 | SR                  | SR                  | 0                                     | 00390039h                                                                                        | 1Fh                                                                                | 1Fh                                                                                       | 3Fh                                                                                    | 1Fh                                                                                |
| 2                                   | 800                   | 1.25, 1.35, 1.5 | DR                  | DR                  | 0                                     | 00390039h                                                                                        | 1Fh                                                                                | 1Fh                                                                                       | 3Fh                                                                                    | 1Fh                                                                                |
| 2                                   | 800                   | 1.25, 1.35, 1.5 | DR                  | SR                  | 0                                     | 00390039h                                                                                        | 1Fh                                                                                | 1Fh                                                                                       | 3Fh                                                                                    | 1Fh                                                                                |

Table 26: BIOS Recommendations for DDR3 UDIMM CAD bus configuration

| Condition                           |                            |                      |                          |                          | D18F2x94_dct[3:0]<br>[SlowAccessMode] | {0000000000b<br>,AddrCmd-<br>Setup[5:0],00b<br>,CsOdt-<br>Setup[5:0],<br>00b, Cke-<br>Setup[5:0]} | D18F2x9C_x0[3,1:0][F,3:0]0_[F,B:0]041_dct[3:0]<br>[DrvStrenN] <sup>2</sup> for CKE | D18F2x9C_x0[3,1:0][F,3:0]0_[F,B:0]041_dct[3:0]<br>[DrvStrenN] <sup>2</sup> for CS and ODT | D18F2x9C_x0[3,1:0][F,3:0]0_[F,B:0]041_dct[3:0]<br>[DrvStrenN] <sup>2</sup> for AddrCmd | D18F2x9C_x0[3,1:0][F,3:0]0_[F,B:0]041_dct[3:0]<br>[DrvStrenN] <sup>2</sup> for CLK |
|-------------------------------------|----------------------------|----------------------|--------------------------|--------------------------|---------------------------------------|---------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|
| Condition:N<br>umDi<br>mmS-<br>lots | Condi-<br>tion:Ddr<br>Rate | Condi-<br>tion:VDDIO | Condi-<br>tion:DI<br>MM0 | Condi-<br>tion:DI<br>MM1 |                                       |                                                                                                   |                                                                                    |                                                                                           |                                                                                        |                                                                                    |
| 2                                   | 800                        | 1.25, 1.35, 1.5      | SR                       | DR                       | 0                                     | 00390039h                                                                                         | 1Fh                                                                                | 1Fh                                                                                       | 3Fh                                                                                    | 1Fh                                                                                |
| 2                                   | 1066                       | 1.25, 1.35, 1.5      | NP                       | SR                       | 0                                     | 00000000h                                                                                         | 1Fh                                                                                | 1Fh                                                                                       | 1Fh                                                                                    | 1Fh                                                                                |
| 2                                   | 1066                       | 1.25, 1.35, 1.5      | NP                       | DR                       | 0                                     | 00380000h                                                                                         | 1Fh                                                                                | 1Fh                                                                                       | 1Fh                                                                                    | 1Fh                                                                                |
| 2                                   | 1066                       | 1.25, 1.35, 1.5      | SR                       | SR                       | 0                                     | 00350037h                                                                                         | 1Fh                                                                                | 1Fh                                                                                       | 3Fh                                                                                    | 1Fh                                                                                |
| 2                                   | 1066                       | 1.25, 1.35, 1.5      | DR                       | DR                       | 0                                     | 00350037h                                                                                         | 1Fh                                                                                | 1Fh                                                                                       | 3Fh                                                                                    | 1Fh                                                                                |
| 2                                   | 1066                       | 1.25, 1.35, 1.5      | DR                       | SR                       | 0                                     | 00350037h                                                                                         | 1Fh                                                                                | 1Fh                                                                                       | 3Fh                                                                                    | 1Fh                                                                                |
| 2                                   | 1066                       | 1.25, 1.35, 1.5      | SR                       | DR                       | 0                                     | 00350037h                                                                                         | 1Fh                                                                                | 1Fh                                                                                       | 3Fh                                                                                    | 1Fh                                                                                |
| 2                                   | 1333                       | 1.25, 1.35, 1.5      | NP                       | SR                       | 0                                     | 00000000h                                                                                         | 1Fh                                                                                | 1Fh                                                                                       | 1Fh                                                                                    | 1Fh                                                                                |
| 2                                   | 1333                       | 1.25, 1.35, 1.5      | NP                       | DR                       | 0                                     | 00360000h                                                                                         | 1Fh                                                                                | 1Fh                                                                                       | 1Fh                                                                                    | 1Fh                                                                                |
| 2                                   | 1333                       | 1.25, 1.35, 1.5      | SR                       | SR                       | 1                                     | 00000035h                                                                                         | 1Fh                                                                                | 1Fh                                                                                       | 3Fh                                                                                    | 1Fh                                                                                |
| 2                                   | 1333                       | 1.25, 1.35, 1.5      | DR                       | DR                       | 1                                     | 00000035h                                                                                         | 1Fh                                                                                | 1Fh                                                                                       | 3Fh                                                                                    | 1Fh                                                                                |
| 2                                   | 1333                       | 1.25, 1.35, 1.5      | DR                       | SR                       | 1                                     | 00000035h                                                                                         | 1Fh                                                                                | 1Fh                                                                                       | 3Fh                                                                                    | 1Fh                                                                                |
| 2                                   | 1333                       | 1.25, 1.35, 1.5      | SR                       | DR                       | 1                                     | 00000035h                                                                                         | 1Fh                                                                                | 1Fh                                                                                       | 3Fh                                                                                    | 1Fh                                                                                |
| 2                                   | 1600                       | 1.25, 1.35, 1.5      | NP                       | SR                       | 0                                     | 00000000h                                                                                         | 1Fh                                                                                | 1Fh                                                                                       | 1Fh                                                                                    | 1Fh                                                                                |
| 2                                   | 1600                       | 1.25, 1.35, 1.5      | NP                       | DR                       | 1                                     | 00000000h                                                                                         | 1Fh                                                                                | 1Fh                                                                                       | 1Fh                                                                                    | 1Fh                                                                                |
| 2                                   | 1600                       | 1.35, 1.5            | SR                       | SR                       | 1                                     | 0000002Bh                                                                                         | 1Fh                                                                                | 1Fh                                                                                       | 3Fh                                                                                    | 1Fh                                                                                |
| 2                                   | 1600                       | 1.35, 1.5            | DR                       | DR                       | 1                                     | 0000002Bh                                                                                         | 1Fh                                                                                | 1Fh                                                                                       | 3Fh                                                                                    | 1Fh                                                                                |
| 2                                   | 1600                       | 1.35, 1.5            | DR                       | SR                       | 1                                     | 0000002Bh                                                                                         | 1Fh                                                                                | 1Fh                                                                                       | 3Fh                                                                                    | 1Fh                                                                                |
| 2                                   | 1600                       | 1.35, 1.5            | SR                       | DR                       | 1                                     | 0000002Bh                                                                                         | 1Fh                                                                                | 1Fh                                                                                       | 3Fh                                                                                    | 1Fh                                                                                |
| 2                                   | 1866                       | 1.35, 1.5            | NP                       | SR                       | 0                                     | 003C3C3Ch                                                                                         | 1Fh                                                                                | 1Fh                                                                                       | 1Fh                                                                                    | 1Fh                                                                                |
| 2                                   | 1866                       | 1.35, 1.5            | NP                       | DR                       | 1                                     | 00003C3Ch                                                                                         | 1Fh                                                                                | 1Fh                                                                                       | 1Fh                                                                                    | 1Fh                                                                                |
| 2                                   | 1866                       | 1.5                  | SR                       | SR                       | 1                                     | 00000031h                                                                                         | 1Fh                                                                                | 1Fh                                                                                       | 3Fh                                                                                    | 1Fh                                                                                |
| 2                                   | 1866                       | 1.5                  | DR                       | DR                       | 1                                     | 00000031h                                                                                         | 1Fh                                                                                | 1Fh                                                                                       | 3Fh                                                                                    | 1Fh                                                                                |

Table 26: BIOS Recommendations for DDR3 UDIMM CAD bus configuration

| Condition                                                                                                                                                                      |                   |                 |                 |                 | D18F2x94_dct[3:0]<br>[SlowAccessMode] | {0000000000b<br>,AddrCmd-<br>Setup[5:0],00b<br>,CsOdt-<br>Setup[5:0],<br>00b, Cke-<br>Setup[5:0]} | D18F2x9C_x0[3:1:0][F,3:0]0_[F,B:0]041_dct[3:0]<br>[DrvStrenN] <sup>2</sup> for CKE | D18F2x9C_x0[3:1:0][F,3:0]0_[F,B:0]041_dct[3:0]<br>[DrvStrenN] <sup>2</sup> for CS and ODT | D18F2x9C_x0[3:1:0][F,3:0]0_[F,B:0]041_dct[3:0]<br>[DrvStrenN] <sup>2</sup> for AddrCmd | D18F2x9C_x0[3:1:0][F,3:0]0_[F,B:0]041_dct[3:0]<br>[DrvStrenN] <sup>2</sup> for CLK |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|-----------------|-----------------|-----------------|---------------------------------------|---------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|
| Condition:NumDimmSlots                                                                                                                                                         | Condition:DdrRate | Condition:VDDIO | Condition:DIMM0 | Condition:DIMM1 |                                       |                                                                                                   |                                                                                    |                                                                                           |                                                                                        |                                                                                    |
| 2                                                                                                                                                                              | 1866              | 1.5             | DR              | SR              | 1                                     | 00000031h                                                                                         | 1Fh                                                                                | 1Fh                                                                                       | 3Fh                                                                                    | 1Fh                                                                                |
| 2                                                                                                                                                                              | 1866              | 1.5             | SR              | DR              | 1                                     | 00000031h                                                                                         | 1Fh                                                                                | 1Fh                                                                                       | 3Fh                                                                                    | 1Fh                                                                                |
| 1. BIOS writes the values for AddrCmdSetup, CsOdtSetup, and CkeSetup into the SRAMMsgBlk for each memory P-state.<br>2. BIOS programs DrvStrenP = DrvStrenN for each instance. |                   |                 |                 |                 |                                       |                                                                                                   |                                                                                    |                                                                                           |                                                                                        |                                                                                    |

### 2.9.9.2.5 DRAM Data Bus Configuration

This section describes the settings required for programming the drive settings and slew rates on the data bus pins. The following tables document the data bus values on a per channel basis. DIMM0 is the DIMM closest to the processor on that channel and DIMM1 is the DIMM farthest from the processor on that channel. DIMMs must be populated from farthest slot to closest slot to the processor on a per channel basis (when a daisy chain topology is used). Populations that are not shown in these tables are not supported. These tables document the optimal settings for motherboards which meet the relevant motherboard design guidelines.

- Program D18F2x9C\_x0002\_0087\_dct[3:0][DisAutoComp, DisPredriverCal] = {1,1}.
- Only the value for a single control unit register is described. The values in the tables should be broadcast to all instances of registers of the same control unit type, unless otherwise noted.
- Program D18F2x9C\_x0002\_0087\_dct[3:0][DisAutoComp] = 0.

Table 27: BIOS Recommendations for DDR3 SO-DIMM data bus configuration

| Condition               |                    |                  |                  |                  | RTT_Nom | RTT_Wr | D18F2x9C_x0[3,1:0][F,8:0]1 [F,B:0]041_dcf[3:0]<br>[DrvStrenP] <sup>1</sup> for DQ pins | D18F2x9C_x0[3,1:0][F,8:0]1 [F,B:0]041_dcf[3:0]<br>[DrvStrenP] <sup>1</sup> for DQS pins | D18F2x9C_x0[3,1:0][F,8:0]1 [F,B:0]04D_dcf[3:0]<br>[ODTStrenP] <sup>2</sup> |
|-------------------------|--------------------|------------------|------------------|------------------|---------|--------|----------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|----------------------------------------------------------------------------|
| Condition: NumDimmSlots | Condition: DdrRate | Condition: VDDIO | Condition: DIMM0 | Condition: DIMM1 |         |        |                                                                                        |                                                                                         |                                                                            |
| 1                       | 667                | 1.25, 1.35, 1.5  | SR               | -                | 120     | Off    | 70h                                                                                    | 70h                                                                                     | 01h                                                                        |
| 1                       | 667                | 1.25, 1.35, 1.5  | DR               | -                | 120     | Off    | 70h                                                                                    | 70h                                                                                     | 01h                                                                        |
| 1                       | 800                | 1.25, 1.35, 1.5  | SR               | -                | 120     | Off    | 70h                                                                                    | 70h                                                                                     | 01h                                                                        |
| 1                       | 800                | 1.25, 1.35, 1.5  | DR               | -                | 120     | Off    | 70h                                                                                    | 70h                                                                                     | 01h                                                                        |
| 1                       | 1066               | 1.25, 1.35, 1.5  | SR               | -                | 120     | Off    | 70h                                                                                    | 70h                                                                                     | 04h                                                                        |
| 1                       | 1066               | 1.25, 1.35, 1.5  | DR               | -                | 120     | Off    | 70h                                                                                    | 70h                                                                                     | 04h                                                                        |
| 1                       | 1333               | 1.25, 1.35, 1.5  | SR               | -                | 60      | Off    | 70h                                                                                    | 70h                                                                                     | 05h                                                                        |
| 1                       | 1333               | 1.25, 1.35, 1.5  | DR               | -                | 60      | Off    | 70h                                                                                    | 70h                                                                                     | 05h                                                                        |
| 1                       | 1600               | 1.25, 1.35, 1.5  | SR               | -                | 60      | Off    | 70h                                                                                    | 70h                                                                                     | 0Ch                                                                        |
| 1                       | 1600               | 1.25, 1.35, 1.5  | DR               | -                | 40      | Off    | 70h                                                                                    | 70h                                                                                     | 0Ch                                                                        |
| 1                       | 1866               | 1.35, 1.5        | SR               | -                | 40      | Off    | 70h                                                                                    | 70h                                                                                     | 0Ch                                                                        |
| 1                       | 1866               | 1.35, 1.5        | DR               | -                | 40      | Off    | 70h                                                                                    | 70h                                                                                     | 0Ch                                                                        |
| 1                       | 2133               | 1.5              | SR               | -                | 40      | Off    | 70h                                                                                    | 70h                                                                                     | 0Ch                                                                        |
| 1                       | 2133               | 1.5              | DR               | -                | 40      | Off    | 70h                                                                                    | 70h                                                                                     | 0Ch                                                                        |
| 2                       | 667                | 1.25, 1.35, 1.5  | NP               | SR               | 120     | Off    | 70h                                                                                    | 70h                                                                                     | 01h                                                                        |
| 2                       | 667                | 1.25, 1.35, 1.5  | NP               | DR               | 120     | Off    | 70h                                                                                    | 70h                                                                                     | 01h                                                                        |
| 2                       | 667                | 1.25, 1.35, 1.5  | SR               | SR               | 40      | 120    | 75h                                                                                    | 75h                                                                                     | 04h                                                                        |
| 2                       | 667                | 1.25, 1.35, 1.5  | DR               | DR               | 40      | 120    | 75h                                                                                    | 75h                                                                                     | 04h                                                                        |
| 2                       | 667                | 1.25, 1.35, 1.5  | DR               | SR               | 40      | 120    | 75h                                                                                    | 75h                                                                                     | 04h                                                                        |
| 2                       | 667                | 1.25, 1.35, 1.5  | SR               | DR               | 40      | 120    | 75h                                                                                    | 75h                                                                                     | 04h                                                                        |
| 2                       | 800                | 1.25, 1.35, 1.5  | NP               | SR               | 120     | Off    | 70h                                                                                    | 70h                                                                                     | 01h                                                                        |
| 2                       | 800                | 1.25, 1.35, 1.5  | NP               | DR               | 120     | Off    | 70h                                                                                    | 70h                                                                                     | 01h                                                                        |
| 2                       | 800                | 1.25, 1.35, 1.5  | SR               | SR               | 40      | 120    | 75h                                                                                    | 75h                                                                                     | 05h                                                                        |
| 2                       | 800                | 1.25, 1.35, 1.5  | DR               | DR               | 40      | 120    | 75h                                                                                    | 75h                                                                                     | 05h                                                                        |
| 2                       | 800                | 1.25, 1.35, 1.5  | DR               | SR               | 40      | 120    | 75h                                                                                    | 75h                                                                                     | 05h                                                                        |

Table 27: BIOS Recommendations for DDR3 SO-DIMM data bus configuration

| Condition               |                    |                  |                  |                  | RTT_Nom | RTT_Wr | D18F2x9C_x0[3,1:0][F,8:0]1 [F,B:0]041_dec[3:0]<br>[DrvStrenP] <sup>1</sup> for DQ pins | D18F2x9C_x0[3,1:0][F,8:0]1 [F,B:0]041_dec[3:0]<br>[DrvStrenP] <sup>2</sup> | D18F2x9C_x0[3,1:0][F,8:0]1 [F,B:0]041_dec[3:0]<br>[ODTStrenP] <sup>2</sup> |
|-------------------------|--------------------|------------------|------------------|------------------|---------|--------|----------------------------------------------------------------------------------------|----------------------------------------------------------------------------|----------------------------------------------------------------------------|
| Condition: NumDimmSlots | Condition: DdrRate | Condition: VDDIO | Condition: DIMM0 | Condition: DIMM1 |         |        |                                                                                        |                                                                            |                                                                            |
| 2                       | 800                | 1.25, 1.35, 1.5  | SR               | DR               | 40      | 120    | 75h                                                                                    | 75h                                                                        | 05h                                                                        |
| 2                       | 1066               | 1.25, 1.35, 1.5  | NP               | SR               | 120     | Off    | 70h                                                                                    | 70h                                                                        | 04h                                                                        |
| 2                       | 1066               | 1.25, 1.35, 1.5  | NP               | DR               | 120     | Off    | 70h                                                                                    | 70h                                                                        | 04h                                                                        |
| 2                       | 1066               | 1.25, 1.35, 1.5  | SR               | SR               | 40      | 120    | 75h                                                                                    | 75h                                                                        | 0Ch                                                                        |
| 2                       | 1066               | 1.25, 1.35, 1.5  | DR               | DR               | 40      | 120    | 75h                                                                                    | 75h                                                                        | 0Ch                                                                        |
| 2                       | 1066               | 1.25, 1.35, 1.5  | DR               | SR               | 40      | 120    | 75h                                                                                    | 75h                                                                        | 0Ch                                                                        |
| 2                       | 1066               | 1.25, 1.35, 1.5  | SR               | DR               | 40      | 120    | 75h                                                                                    | 75h                                                                        | 0Ch                                                                        |
| 2                       | 1333               | 1.25, 1.35, 1.5  | NP               | SR               | 60      | Off    | 70h                                                                                    | 70h                                                                        | 05h                                                                        |
| 2                       | 1333               | 1.25, 1.35, 1.5  | NP               | DR               | 60      | Off    | 70h                                                                                    | 70h                                                                        | 05h                                                                        |
| 2                       | 1333               | 1.25, 1.35, 1.5  | SR               | SR               | 30      | 120    | 75h                                                                                    | 75h                                                                        | 0Ch                                                                        |
| 2                       | 1333               | 1.25, 1.35, 1.5  | DR               | DR               | 30      | 120    | 75h                                                                                    | 75h                                                                        | 0Ch                                                                        |
| 2                       | 1333               | 1.25, 1.35, 1.5  | DR               | SR               | 30      | 120    | 75h                                                                                    | 75h                                                                        | 0Ch                                                                        |
| 2                       | 1333               | 1.25, 1.35, 1.5  | SR               | DR               | 30      | 120    | 75h                                                                                    | 75h                                                                        | 0Ch                                                                        |
| 2                       | 1600               | 1.25, 1.35, 1.5  | NP               | SR               | 40      | Off    | 70h                                                                                    | 70h                                                                        | 0Ch                                                                        |
| 2                       | 1600               | 1.25, 1.35, 1.5  | NP               | DR               | 40      | Off    | 70h                                                                                    | 70h                                                                        | 0Ch                                                                        |
| 2                       | 1600               | 1.35, 1.5        | SR               | SR               | 20      | 60     | 75h                                                                                    | 75h                                                                        | 0Ch                                                                        |
| 2                       | 1600               | 1.35, 1.5        | DR               | DR               | 20      | 60     | 75h                                                                                    | 75h                                                                        | 0Ch                                                                        |
| 2                       | 1600               | 1.35, 1.5        | DR               | SR               | 20      | 60     | 75h                                                                                    | 75h                                                                        | 0Ch                                                                        |
| 2                       | 1600               | 1.35, 1.5        | SR               | DR               | 20      | 60     | 75h                                                                                    | 75h                                                                        | 0Ch                                                                        |
| 2                       | 1866               | 1.35, 1.5        | NP               | SR               | 40      | Off    | 70h                                                                                    | 70h                                                                        | 0Ch                                                                        |
| 2                       | 1866               | 1.35, 1.5        | NP               | DR               | 40      | Off    | 70h                                                                                    | 70h                                                                        | 0Ch                                                                        |
| 2                       | 1866               | 1.5              | SR               | SR               | 20      | 60     | 75h                                                                                    | 75h                                                                        | 0Ch                                                                        |
| 2                       | 1866               | 1.5              | DR               | DR               | 20      | 60     | 75h                                                                                    | 75h                                                                        | 0Ch                                                                        |
| 2                       | 1866               | 1.5              | DR               | SR               | 20      | 60     | 75h                                                                                    | 75h                                                                        | 0Ch                                                                        |
| 2                       | 1866               | 1.5              | SR               | DR               | 20      | 60     | 75h                                                                                    | 75h                                                                        | 0Ch                                                                        |

Table 27: BIOS Recommendations for DDR3 SO-DIMM data bus configuration

| Condition                                                                                                                                                                                                                                                                     |                    |                  |                  |                  | RTT_Nom | RTT_Wr | D18F2x9C_x0[3,1:0][F,8:0]1_[F,B:0]041_det[3:0]<br>[DrvStrenP] <sup>1</sup> for DQ pins | D18F2x9C_x0[3,1:0][F,8:0]1_[F,B:0]041_det[3:0]<br>[DrvStrenP] <sup>1</sup> for DQS pins | D18F2x9C_x0[3,1:0][F,8:0]1_[F,B:0]04D_det[3:0]<br>[ODTStrenP] <sup>2</sup> |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|------------------|------------------|------------------|---------|--------|----------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|----------------------------------------------------------------------------|
| Condition: NumDimmSlots                                                                                                                                                                                                                                                       | Condition: DdrRate | Condition: VDDIO | Condition: DIMM0 | Condition: DIMM1 |         |        |                                                                                        |                                                                                         |                                                                            |
| 2                                                                                                                                                                                                                                                                             | 2133               | 1.5              | NP               | SR               | 40      | Off    | 70h                                                                                    | 70h                                                                                     | 0Ch                                                                        |
| 2                                                                                                                                                                                                                                                                             | 2133               | 1.5              | NP               | DR               | 40      | Off    | 70h                                                                                    | 70h                                                                                     | 0Ch                                                                        |
| 1. BIOS programs DrvStrenN = DrvStrenP for each instance.<br>BIOS programs instances for “MEMDQSDM” (when used as a data mask) with the same value as DQ.<br>2. BIOS programs ODTStrenN = ODTStrenP for each instance.<br>BIOS programs all used instances with these values. |                    |                  |                  |                  |         |        |                                                                                        |                                                                                         |                                                                            |

Table 28: BIOS Recommendations for DDR3 UDIMM data bus configuration

| Condition               |                    |                  |                  |                  | RTT_Nom | RTT_Wr | D18F2x9C_x0[3,1:0][F,8:0]1_[F,B:0]041_det[3:0]<br>[DrvStrenP] <sup>1</sup> for DQ pins | D18F2x9C_x0[3,1:0][F,8:0]1_[F,B:0]041_det[3:0]<br>[DrvStrenP] <sup>1</sup> for DQS pins | D18F2x9C_x0[3,1:0][F,8:0]1_[F,B:0]04D_det[3:0]<br>[ODTStrenP] <sup>2</sup> |
|-------------------------|--------------------|------------------|------------------|------------------|---------|--------|----------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|----------------------------------------------------------------------------|
| Condition: NumDimmSlots | Condition: DdrRate | Condition: VDDIO | Condition: DIMM0 | Condition: DIMM1 |         |        |                                                                                        |                                                                                         |                                                                            |
| 1                       | 667                | 1.25, 1.35, 1.5  | SR               | -                | 120     | Off    | 70h                                                                                    | 70h                                                                                     | 01h                                                                        |
| 1                       | 667                | 1.25, 1.35, 1.5  | DR               | -                | 120     | Off    | 70h                                                                                    | 70h                                                                                     | 01h                                                                        |
| 1                       | 800                | 1.25, 1.35, 1.5  | SR               | -                | 120     | Off    | 70h                                                                                    | 70h                                                                                     | 01h                                                                        |

Table 28: BIOS Recommendations for DDR3 UDIMM data bus configuration

| Condition               |                    |                  |                  |                  | RTT_Nom | RTT_Wr | D18F2x9C_x0[3,1:0][F,8:0]1 [F,B:0]041_dec[3:0]<br>[DrvStrenP] <sup>1</sup> for DQ pins | D18F2x9C_x0[3,1:0][F,8:0]1 [F,B:0]041_dec[3:0]<br>[DrvStrenP] <sup>2</sup> | D18F2x9C_x0[3,1:0][F,8:0]1 [F,B:0]041_dec[3:0]<br>[ODTStrenP] <sup>2</sup> |
|-------------------------|--------------------|------------------|------------------|------------------|---------|--------|----------------------------------------------------------------------------------------|----------------------------------------------------------------------------|----------------------------------------------------------------------------|
| Condition: NumDimmSlots | Condition: DdrRate | Condition: VDDIO | Condition: DIMM0 | Condition: DIMM1 |         |        |                                                                                        |                                                                            |                                                                            |
| 1                       | 800                | 1.25, 1.35, 1.5  | DR               | -                | 120     | Off    | 70h                                                                                    | 70h                                                                        | 01h                                                                        |
| 1                       | 1066               | 1.25, 1.35, 1.5  | SR               | -                | 120     | Off    | 70h                                                                                    | 70h                                                                        | 04h                                                                        |
| 1                       | 1066               | 1.25, 1.35, 1.5  | DR               | -                | 120     | Off    | 70h                                                                                    | 70h                                                                        | 04h                                                                        |
| 1                       | 1333               | 1.25, 1.35, 1.5  | SR               | -                | 60      | Off    | 70h                                                                                    | 70h                                                                        | 05h                                                                        |
| 1                       | 1333               | 1.25, 1.35, 1.5  | DR               | -                | 60      | Off    | 70h                                                                                    | 70h                                                                        | 05h                                                                        |
| 1                       | 1600               | 1.25, 1.35, 1.5  | SR               | -                | 60      | Off    | 70h                                                                                    | 70h                                                                        | 0Ch                                                                        |
| 1                       | 1600               | 1.25, 1.35, 1.5  | DR               | -                | 40      | Off    | 70h                                                                                    | 70h                                                                        | 0Ch                                                                        |
| 1                       | 1866               | 1.35, 1.5        | SR               | -                | 40      | Off    | 70h                                                                                    | 70h                                                                        | 0Ch                                                                        |
| 1                       | 1866               | 1.35, 1.5        | DR               | -                | 40      | Off    | 70h                                                                                    | 70h                                                                        | 0Ch                                                                        |
| 1                       | 2133               | 1.5              | SR               | -                | 40      | Off    | 70h                                                                                    | 70h                                                                        | 0Ch                                                                        |
| 1                       | 2133               | 1.5              | DR               | -                | 40      | Off    | 70h                                                                                    | 70h                                                                        | 0Ch                                                                        |
| 2                       | 667                | 1.25, 1.35, 1.5  | NP               | SR               | 120     | Off    | 70h                                                                                    | 70h                                                                        | 01h                                                                        |
| 2                       | 667                | 1.25, 1.35, 1.5  | NP               | DR               | 120     | Off    | 70h                                                                                    | 70h                                                                        | 01h                                                                        |
| 2                       | 667                | 1.25, 1.35, 1.5  | SR               | SR               | 40      | 120    | 75h                                                                                    | 75h                                                                        | 04h                                                                        |
| 2                       | 667                | 1.25, 1.35, 1.5  | DR               | DR               | 40      | 120    | 75h                                                                                    | 75h                                                                        | 04h                                                                        |
| 2                       | 667                | 1.25, 1.35, 1.5  | DR               | SR               | 40      | 120    | 75h                                                                                    | 75h                                                                        | 04h                                                                        |
| 2                       | 667                | 1.25, 1.35, 1.5  | SR               | DR               | 40      | 120    | 75h                                                                                    | 75h                                                                        | 04h                                                                        |
| 2                       | 800                | 1.25, 1.35, 1.5  | NP               | SR               | 120     | Off    | 70h                                                                                    | 70h                                                                        | 01h                                                                        |
| 2                       | 800                | 1.25, 1.35, 1.5  | NP               | DR               | 120     | Off    | 70h                                                                                    | 70h                                                                        | 01h                                                                        |
| 2                       | 800                | 1.25, 1.35, 1.5  | SR               | SR               | 40      | 120    | 75h                                                                                    | 75h                                                                        | 05h                                                                        |
| 2                       | 800                | 1.25, 1.35, 1.5  | DR               | DR               | 40      | 120    | 75h                                                                                    | 75h                                                                        | 05h                                                                        |
| 2                       | 800                | 1.25, 1.35, 1.5  | DR               | SR               | 40      | 120    | 75h                                                                                    | 75h                                                                        | 05h                                                                        |
| 2                       | 800                | 1.25, 1.35, 1.5  | SR               | DR               | 40      | 120    | 75h                                                                                    | 75h                                                                        | 05h                                                                        |
| 2                       | 1066               | 1.25, 1.35, 1.5  | NP               | SR               | 120     | Off    | 70h                                                                                    | 70h                                                                        | 04h                                                                        |
| 2                       | 1066               | 1.25, 1.35, 1.5  | NP               | DR               | 120     | Off    | 70h                                                                                    | 70h                                                                        | 04h                                                                        |
| 2                       | 1066               | 1.25, 1.35, 1.5  | SR               | SR               | 40      | 120    | 75h                                                                                    | 75h                                                                        | 0Ch                                                                        |



Table 28: BIOS Recommendations for DDR3 UDIMM data bus configuration

| Condition               |                    |                  |                  |                  | RTT_Nom | RTT_Wr | D18F2x9C_x0[3,1:0][F,8:0]1 [F,B:0]041_dec[3:0]<br>[DrvStrenP] <sup>1</sup> for DQ pins | D18F2x9C_x0[3,1:0][F,8:0]1 [F,B:0]041_dec[3:0]<br>[DrvStrenP] <sup>2</sup> | D18F2x9C_x0[3,1:0][F,8:0]1 [F,B:0]041_dec[3:0]<br>[ODTStrenP] <sup>2</sup> |
|-------------------------|--------------------|------------------|------------------|------------------|---------|--------|----------------------------------------------------------------------------------------|----------------------------------------------------------------------------|----------------------------------------------------------------------------|
| Condition: NumDimmSlots | Condition: DdrRate | Condition: VDDIO | Condition: DIMM0 | Condition: DIMM1 |         |        |                                                                                        |                                                                            |                                                                            |
| 2                       | 1066               | 1.25, 1.35, 1.5  | DR               | DR               | 40      | 120    | 75h                                                                                    | 75h                                                                        | 0Ch                                                                        |
| 2                       | 1066               | 1.25, 1.35, 1.5  | DR               | SR               | 40      | 120    | 75h                                                                                    | 75h                                                                        | 0Ch                                                                        |
| 2                       | 1066               | 1.25, 1.35, 1.5  | SR               | DR               | 40      | 120    | 75h                                                                                    | 75h                                                                        | 0Ch                                                                        |
| 2                       | 1333               | 1.25, 1.35, 1.5  | NP               | SR               | 60      | Off    | 70h                                                                                    | 70h                                                                        | 05h                                                                        |
| 2                       | 1333               | 1.25, 1.35, 1.5  | NP               | DR               | 60      | Off    | 70h                                                                                    | 70h                                                                        | 05h                                                                        |
| 2                       | 1333               | 1.25, 1.35, 1.5  | SR               | SR               | 30      | 120    | 75h                                                                                    | 75h                                                                        | 0Ch                                                                        |
| 2                       | 1333               | 1.25, 1.35, 1.5  | DR               | DR               | 30      | 120    | 75h                                                                                    | 75h                                                                        | 0Ch                                                                        |
| 2                       | 1333               | 1.25, 1.35, 1.5  | DR               | SR               | 30      | 120    | 75h                                                                                    | 75h                                                                        | 0Ch                                                                        |
| 2                       | 1333               | 1.25, 1.35, 1.5  | SR               | DR               | 30      | 120    | 75h                                                                                    | 75h                                                                        | 0Ch                                                                        |
| 2                       | 1600               | 1.25, 1.35, 1.5  | NP               | SR               | 40      | Off    | 70h                                                                                    | 70h                                                                        | 0Ch                                                                        |
| 2                       | 1600               | 1.25, 1.35, 1.5  | NP               | DR               | 40      | Off    | 70h                                                                                    | 70h                                                                        | 0Ch                                                                        |
| 2                       | 1600               | 1.35, 1.5        | SR               | SR               | 20      | 60     | 75h                                                                                    | 75h                                                                        | 0Ch                                                                        |
| 2                       | 1600               | 1.35, 1.5        | DR               | DR               | 20      | 60     | 75h                                                                                    | 75h                                                                        | 0Ch                                                                        |
| 2                       | 1600               | 1.35, 1.5        | DR               | SR               | 20      | 60     | 75h                                                                                    | 75h                                                                        | 0Ch                                                                        |
| 2                       | 1600               | 1.35, 1.5        | SR               | DR               | 20      | 60     | 75h                                                                                    | 75h                                                                        | 0Ch                                                                        |
| 2                       | 1866               | 1.35, 1.5        | NP               | SR               | 40      | Off    | 70h                                                                                    | 70h                                                                        | 0Ch                                                                        |
| 2                       | 1866               | 1.35, 1.5        | NP               | DR               | 40      | Off    | 70h                                                                                    | 70h                                                                        | 0Ch                                                                        |
| 2                       | 1866               | 1.5              | SR               | SR               | 20      | 60     | 75h                                                                                    | 75h                                                                        | 0Ch                                                                        |
| 2                       | 1866               | 1.5              | DR               | DR               | 20      | 60     | 75h                                                                                    | 75h                                                                        | 0Ch                                                                        |
| 2                       | 1866               | 1.5              | DR               | SR               | 20      | 60     | 75h                                                                                    | 75h                                                                        | 0Ch                                                                        |
| 2                       | 1866               | 1.5              | SR               | DR               | 20      | 60     | 75h                                                                                    | 75h                                                                        | 0Ch                                                                        |

Table 28: BIOS Recommendations for DDR3 UDIMM data bus configuration

| Condition                                                                                                                                                                                                                                                                     |                    |                  |                  |                  | RTT_Nom | RTT_Wr | D18F2x9C_x0[3,1:0][F,8:0]1 [F,B:0]041_dct[3:0]<br>[DrvStrenP] <sup>1</sup> for DQ pins | D18F2x9C_x0[3,1:0][F,8:0]1 [F,B:0]041_dct[3:0]<br>[DrvStrenP] <sup>1</sup> for DQS pins | D18F2x9C_x0[3,1:0][F,8:0]1 [F,B:0]04D_dct[3:0]<br>[ODTStrenP] <sup>2</sup> |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|------------------|------------------|------------------|---------|--------|----------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|----------------------------------------------------------------------------|
| Condition: NumDimmSlots                                                                                                                                                                                                                                                       | Condition: DdrRate | Condition: VDDIO | Condition: DIMM0 | Condition: DIMM1 |         |        |                                                                                        |                                                                                         |                                                                            |
| 2                                                                                                                                                                                                                                                                             | 2133               | 1.5              | NP               | SR               | 40      | Off    | 70h                                                                                    | 70h                                                                                     | 0Ch                                                                        |
| 2                                                                                                                                                                                                                                                                             | 2133               | 1.5              | NP               | DR               | 40      | Off    | 70h                                                                                    | 70h                                                                                     | 0Ch                                                                        |
| 1. BIOS programs DrvStrenN = DrvStrenP for each instance.<br>BIOS programs instances for “MEMDQSDM” (when used as a data mask) with the same value as DQ.<br>2. BIOS programs ODTStrenN = ODTStrenP for each instance.<br>BIOS programs all used instances with these values. |                    |                  |                  |                  |         |        |                                                                                        |                                                                                         |                                                                            |

### 2.9.9.2.6 Phy FIFO Configuration

BIOS programs FIFO configuration values based on NCLK, memory clock, CASL, and CWL. A read pointer initial value is specified for each NbPstate as well as one reserved for the PMU during training.

The steps for **Ddr3Mode** are as follows:

- For NbP0 broadcast the value to all timing groups and chips as follows:
  - D18F2x9C\_x00[F,3:0]0 [F,3:0][8,3:0]2E\_dct[3:0][RdPtrInitVal]= Table 29.
  - D18F2x9C\_x00[F,8:0]1\_0[8,3:0]2E\_dct[3:0][RdPtrInitVal] = Table 29.
- For each NbPstate, excluding the “NbPstate PMU” instance and the NbP0 instance, program:
  - Broadcast the value to all timing groups and chips.
  - D18F2x9C\_x00[F,3:0]0 [F,3:0][8,3:0]2E\_dct[3:0][RdPtrInitVal]= Table 30.
  - D18F2x9C\_x00[F,8:0]1\_0[8,3:0]2E\_dct[3:0][RdPtrInitVal] = Table 30.
- D18F2x9C\_x0[3,1:0][F,8:0]1\_0028\_dct[3:0][RxRdPtrOffset] as follows:
  - Broadcast the value to all chips.
  - RxRdPtrOffset = CASL.
- D18F2x9C\_x0[3,1:0][F,8:0]1\_0028\_dct[3:0][TxRdPtrOffset] as follows:
  - Broadcast the value to all chips.
  - TxRdPtrOffset = CWL.

Table 29: BIOS Recommendations for DDR3 FIFO RdPtrInitVal for NbP0

| Condition              | NCLK (MHz) |      |      |      |      |      |      |
|------------------------|------------|------|------|------|------|------|------|
| Condi-<br>tion:DdrRate | 800        | 1000 | 1200 | 1400 | 1600 | 1800 | 1900 |
| 667                    | 10h        | 14h  | 14h  | 14h  | 14h  | 14h  | 14h  |
| 1066                   | 0Ch        | 10h  | 10h  | 10h  | 10h  | 10h  | 10h  |
| 1333                   | 08h        | 0Ch  | 0Ch  | 0Ch  | 10h  | 10h  | 10h  |
| 1600                   | 08h        | 08h  | 08h  | 0Ch  | 0Ch  | 0Ch  | 0Ch  |
| 1866                   | -          | 04h  | 08h  | 08h  | 08h  | 0Ch  | 0Ch  |
| 2133                   | -          | -    | 04h  | 04h  | 08h  | 08h  | 08h  |
| 2400                   | -          | -    | 04h  | 04h  | 04h  | 04h  | 04h  |
| 2500                   | -          | -    | -    | 04h  | 04h  | 04h  | 04h  |

Notes:

1. If exact DdrRate is not shown, use the information from the row of the next highest shown DdrRate.
2. If exact NCLK rate is not shown, use the information from the column of the next highest shown NCLK.
3. Not all conditions are supported. See product definition for details on supported frequencies.

Table 30: BIOS Recommendations for DDR3 FIFO RdPtrInitVal for NbPx

| Condition              | NCLK (MHz) |      |      |      |      |      |      |
|------------------------|------------|------|------|------|------|------|------|
| Condi-<br>tion:DdrRate | 800        | 1000 | 1200 | 1400 | 1600 | 1800 | 1900 |
| 667                    | 10h        | 10h  | 10h  | 14h  | 14h  | 14h  | 14h  |
| 1066                   | 0Ch        | 0Ch  | 0Ch  | 0Ch  | 10h  | 10h  | 10h  |
| 1333                   | 08h        | 08h  | 08h  | 0Ch  | 0Ch  | 0Ch  | 0Ch  |
| 1600                   | 08h        | 04h  | 08h  | 08h  | 08h  | 08h  | 08h  |
| 1866                   | -          | 00h  | 04h  | 04h  | 04h  | 08h  | 08h  |
| 2133                   | -          | -    | 00h  | 00h  | 04h  | 04h  | 04h  |
| 2400                   | -          | -    | 00h  | 00h  | 00h  | 00h  | 00h  |
| 2500                   | -          | -    | -    | 7Ch  | 00h  | 00h  | 00h  |

Notes:

1. If exact DdrRate is not shown, use the information from the row of the next highest shown DdrRate.
2. If exact NCLK rate is not shown, use the information from the column of the next highest shown NCLK.
3. Not all conditions are supported. See product definition for details on supported frequencies.

#### 2.9.9.2.7 Phy Predriver Initialization.

Each DDR IO driver has a programmable slew rate controlled by the pre-driver calibration code. The recommended slew rate is a function of the DC drive strength. BIOS initializes the recommended nominal slew rate

values as follows:

1. Program `D18F2x9C_x0002_0087_dct[3:0][DisAutoComp, DisPredriverCal] = {1,1}`.
2. Program `D18F2x9C_x00[F,8:0]1_[F,B:0]05F_dct[3:0][TxPreN, TxPreP]` according to [Table 31](#)
  - For each pad, read `D18F2x9C_x0[3,1:0][F,8:0]1_[F,B:0]041_dct[3:0][DrvStrenP]` and program the corresponding pad in `D18F2x9C_x00[F,8:0]1_[F,B:0]05F_dct[3:0]`.
  - Use DrvStrenP for memory P-state 0 to determine slew rate.
  - If the chosen DrvStrenP value is not listed in the table for the given DDR rates, then use the next lower DrvStrenP value listed to determine TxPreN and TxPreP.
3. Program `D18F2x9C_x00[F,3:0]0_[F,B:0]05F_dct[3:0][TxPreN, TxPreP]` for Cmd/Addr according to [Table 32](#).
  - For each Cmd/Addr pad (MEMCKE[3:0], MEMADD[15:0], MEMBANK[2:0], MEMCS\_L[7:0], MEMODT[3:0], MEMCAS\_L, MEMWE\_L, MEMRAS\_L):
    - Read `D18F2x9C_x0[3,1:0][F,3:0]0_[F,B:0]041_dct[3:0][DrvStrenP]` and program the corresponding pad in `D18F2x9C_x00[F,3:0]0_[F,B:0]05F_dct[3:0][TxPreN, TxPreP]`.
  - Use DrvStrenP for memory P-state 0 to determine slew rate.
  - If the chosen DrvStrenP value is not listed in the table for the given DDR rates, then use the next lower DrvStrenP value listed to determine TxPreN and TxPreP.
4. Program `D18F2x9C_x00[F,3:0]0_[F,B:0]05F_dct[3:0][TxPreN, TxPreP]` for clocks according to [Table 33](#).
  - For each clock pad (MEMCLK\_H[4:0], MEMCLK\_L[4:0]):
    - Read `D18F2x9C_x0[3,1:0][F,3:0]0_[F,B:0]041_dct[3:0][DrvStrenP]` and program the corresponding pad in `D18F2x9C_x00[F,3:0]0_[F,B:0]05F_dct[3:0][TxPreN, TxPreP]`.
  - Use DrvStrenP for memory P-state 0 to determine slew rate.
  - If the chosen DrvStrenP value is not listed in the table for the given DDR rates, then use the next lower DrvStrenP value listed to determine TxPreN and TxPreP.
5. Program `D18F2x9C_x0002_0087_dct[3:0][DisAutoComp, DisPredriverCal] = {0,0}`.

**Table 31: Phy predriver codes for Data/DQS**

| DDR Rate                                                             | DrvStrenP <sup>1</sup> | {TxPreN, TxPreP} <sup>2</sup><br>VDDIO=1.5V | {TxPreN, TxPreP} <sup>2</sup><br>VDDIO=1.35V | {TxPreN, TxPreP} <sup>2</sup><br>VDDIO=1.25V |
|----------------------------------------------------------------------|------------------------|---------------------------------------------|----------------------------------------------|----------------------------------------------|
| 667 - 1067                                                           | 31h                    | 101b,111b                                   | 101b,111b                                    | 101b,111b                                    |
|                                                                      | 70h                    | 010b,010b                                   | 101b,111b                                    | 101b,111b                                    |
|                                                                      | 75h                    | 001b,001b                                   | 010b,010b                                    | 010b,010b                                    |
|                                                                      | 7Fh                    | 001b,001b                                   | 001b,001b                                    | 001b,001b                                    |
| 1333 - 1600                                                          | 31h                    | 101b,111b                                   | 101b,111b                                    | 101b,111b                                    |
|                                                                      | 70h                    | 010b,010b                                   | 101b,111b                                    | 101b,111b                                    |
|                                                                      | 75h                    | 010b,010b                                   | 010b,010b                                    | 011b,011b                                    |
|                                                                      | 7Fh                    | 010b,010b                                   | 010b,010b                                    | 011b,011b                                    |
| 1866 - 2400                                                          | 31h                    | 101b,111b                                   | 101b,111b                                    | 101b,111b                                    |
|                                                                      | 70h                    | 011b,011b                                   | 101b,111b                                    | 101b,111b                                    |
|                                                                      | 75h                    | 011b,011b                                   | 100b,100b                                    | 100b,100b                                    |
|                                                                      | 7Fh                    | 011b,011b                                   | 100b,100b                                    | 100b,101b                                    |
| 1. See <code>D18F2x9C_x0[3,1:0][F,8:0]1_[F,B:0]041_dct[3:0]</code> . |                        |                                             |                                              |                                              |
| 2. See <code>D18F2x9C_x00[F,8:0]1_[F,B:0]05F_dct[3:0]</code> .       |                        |                                             |                                              |                                              |

**Table 32: Phy predriver codes for Cmd/Addr**

| DDR Rate                                                                                                   | DrvStrenP <sup>1</sup> | {TxPreN, TxPreP} <sup>2</sup><br>VDDIO=1.5V | {TxPreN, TxPreP} <sup>2</sup><br>VDDIO=1.35V | {TxPreN, TxPreP} <sup>2</sup><br>VDDIO=1.25V |
|------------------------------------------------------------------------------------------------------------|------------------------|---------------------------------------------|----------------------------------------------|----------------------------------------------|
| 667 - 1067                                                                                                 | 07h                    | 000b,000b                                   | 001b,001b                                    | 001b,001b                                    |
|                                                                                                            | 0Fh                    | 000b,000b                                   | 001b,001b                                    | 001b,001b                                    |
|                                                                                                            | 1Fh                    | 000b,000b                                   | 001b,001b                                    | 001b,001b                                    |
|                                                                                                            | 3Fh                    | 000b,000b                                   | 001b,001b                                    | 001b,001b                                    |
| 1333 - 1600                                                                                                | 07h                    | 001b,001b                                   | 010b,010b                                    | 011b,011b                                    |
|                                                                                                            | 0Fh                    | 001b,001b                                   | 010b,010b                                    | 011b,011b                                    |
|                                                                                                            | 1Fh                    | 001b,001b                                   | 010b,010b                                    | 011b,011b                                    |
|                                                                                                            | 3Fh                    | 001b,001b                                   | 010b,010b                                    | 011b,011b                                    |
| 1866 - 2400                                                                                                | 07h                    | 011b,011b                                   | 011b,011b                                    | 100b,100b                                    |
|                                                                                                            | 0Fh                    | 011b,011b                                   | 011b,011b                                    | 100b,100b                                    |
|                                                                                                            | 1Fh                    | 011b,011b                                   | 011b,011b                                    | 100b,100b                                    |
|                                                                                                            | 3Fh                    | 011b,011b                                   | 011b,011b                                    | 100b,100b                                    |
| 1. See D18F2x9C_x0[3,1:0][F,3:0]0_[F,B:0]041_dct[3:0].<br>2. See D18F2x9C_x00[F,3:0]0_[F,B:0]05F_dct[3:0]. |                        |                                             |                                              |                                              |

**Table 33: Phy predriver codes for CLK**

| DDR Rate                                                                                                   | DrvStrenP <sup>1</sup> | {TxPreN, TxPreP} <sup>2</sup><br>VDDIO=1.5V | {TxPreN, TxPreP} <sup>2</sup><br>VDDIO=1.35V | {TxPreN, TxPreP} <sup>2</sup><br>VDDIO=1.25V |
|------------------------------------------------------------------------------------------------------------|------------------------|---------------------------------------------|----------------------------------------------|----------------------------------------------|
| 667 - 1067                                                                                                 | 07h                    | 010b,010b                                   | 011b,011b                                    | 100b,100b                                    |
|                                                                                                            | 0Fh                    | 010b,010b                                   | 011b,011b                                    | 100b,100b                                    |
|                                                                                                            | 1Fh                    | 010b,010b                                   | 011b,011b                                    | 100b,100b                                    |
|                                                                                                            | 3Fh                    | 010b,010b                                   | 011b,011b                                    | 100b,100b                                    |
| 1333 - 1600                                                                                                | 07h                    | 100b,100b                                   | 101b,101b                                    | 110b,110b                                    |
|                                                                                                            | 0Fh                    | 100b,100b                                   | 101b,101b                                    | 110b,110b                                    |
|                                                                                                            | 1Fh                    | 100b,100b                                   | 101b,101b                                    | 110b,110b                                    |
|                                                                                                            | 3Fh                    | 100b,100b                                   | 101b,101b                                    | 110b,110b                                    |
| 1866 - 2400                                                                                                | 07h                    | 111b,111b                                   | 111b,111b                                    | 111b,111b                                    |
|                                                                                                            | 0Fh                    | 111b,111b                                   | 111b,111b                                    | 111b,111b                                    |
|                                                                                                            | 1Fh                    | 111b,111b                                   | 111b,111b                                    | 111b,111b                                    |
|                                                                                                            | 3Fh                    | 111b,111b                                   | 111b,111b                                    | 111b,111b                                    |
| 1. See D18F2x9C_x0[3,1:0][F,3:0]0_[F,B:0]041_dct[3:0].<br>2. See D18F2x9C_x00[F,3:0]0_[F,B:0]05F_dct[3:0]. |                        |                                             |                                              |                                              |

### 2.9.9.2.8 Phy Auto-Calibration

BIOS enables a one-time calibration after configuration dependent values are programmed as follows:

1. Initiate one-time calibration. See 2.9.9.2.8.1.
2. After the PMU firmware is loaded, BIOS ensures that the initial calibration is complete prior to executing PMU firmware. See appropriate section for details.
3. After PMU training is complete, or after complete restore of trained values from NVRAM, BIOS initiates auto calibration. See 2.9.9.2.8.3

#### 2.9.9.2.8.1 One-Time Pre-PMU Calibration

BIOS initiates one calibration. On S5 boot BIOS does this before loading PMU firmware.

1. Program `D18F2x9C_x0002_0088_dct[3:0][CalInitMode, CalOnce] = {1,1}`.
2. Program `D18F2x9C_x0002_0088_dct[3:0][CalRun] = 1`.
3. Program `D18F2x9C_x0002_0088_dct[3:0][CalOnce, CalRun] = {0,0}`.

#### 2.9.9.2.8.2 Fence CalOnce

BIOS ensures the initial one-time calibration is complete as follows:

1. Read `D18F2x9C_x0002_0097_dct[3:0][CalBusy]`. This read value is thrown away.
2. Read `D18F2x9C_x0002_0097_dct[3:0][CalBusy]` until `CalBusy = 0`.

#### 2.9.9.2.8.3 Auto Calibration

BIOS initiates auto calibration after PMU training or after complete restore of trained values from NVRAM.

1. Program `D18F2x9C_x0002_0088_dct[3:0][CalInitMode] = 0`.
2. Program `D18F2x9C_x0002_0088_dct[3:0][CalRun] = 1`.

### 2.9.9.2.9 PMU Firmware Load

BIOS loads the PMU firmware (see 2.9.8 [PMU]) after each system reset before requesting the PMU to take action with down-stream messages.

Firmware block LENGTH = 16\*1024.

1. Program `D18F2x9C_x0002_0099_dct[3:0][PmuReset] = 0` for each phy.
2. Program `D18F1x10C[DctCfgBcEn] = 1`.
3. For each 16-bit word of the firmware block: Write the word to `D18F2x[B,0]9C_x0005_[5BFF:4000]_dct[3:0]` (while using the autoincrement feature).
4. Program `D18F1x10C[DctCfgBcEn] = 0`.

Additionally, there is a sequence of register writes provided by AMD to write compiler/tool specific data into the data SRAM for use in the PMU executive.

### 2.9.9.2.10 Phy Registers Required for S3 Resume

To support suspend-to-RAM, BIOS must save registers to NVRAM prior to S3 entry, and restore them when resuming. The following is not a complete list. See 2.9.9 [DCT/DRAM Initialization and Resume] for information on other registers. BIOS restores the following registers, which have been trained by the PMU during boot:

- D18F2x9C\_x0[3,1:0][F,3:0]0\_F[3:0]028\_dct[3:0]
- D18F2x9C\_x0[3,1:0][F,8:0]1\_0028\_dct[3:0]
- D18F2x9C\_x0[3,1:0][F,3:0]0\_F[3:0]081\_dct[3:0]
- D18F2x9C\_x0[F,1:0][F,8:0]1\_F[9:0][F,3:0]80\_dct[3:0]
- D18F2x9C\_x0[F,1:0][F,8:0]1\_F[9:0][F,3:0]81\_dct[3:0]
- D18F2x9C\_x0[3,1:0][F,8:0]1\_F[B:0]046\_dct[3:0]
- D18F2x9C\_x0[3,1:0][F,8:0]1\_F[B:0]047\_dct[3:0]
- D18F2x9C\_x0[3,1:0][F,8:0]1\_F[B:0]048\_dct[3:0]

### 2.9.9.2.11 Calculating Round Trip Command Delays

Software calculates trained round trip delays as follows.

MaxRxCmdDelay, maximum command to data read delay, in units of 2 UI:

- Compute worst case for each chip and when available for each DQ pad within a chip.
- $\text{MaxRxCmdDelay} = \text{MAX}(\text{D18F2x9C\_x0[3,1:0][F,8:0]1\_0028\_dct[3:0][RxRdPtrOffset]} + \text{CEIL}(\text{D18F2x9C\_x0[F,1:0][F,8:0]1\_F[9:0][F,3:0]80\_dct[3:0][RxDly]/64))$

### 2.9.9.3 SPD ROM-Based Configuration

The Serial Presence Detect (SPD) ROM is a non-volatile memory device on the DIMM encoded by the DIMM manufacturer. The description of the SPD is usually provided on a data sheet for the DIMM itself along with data describing the memory devices used. The data describes configuration and speed characteristics of the DIMM and the SDRAM components mounted on the DIMM. The associated data sheet also contains the DIMM byte values that are encoded in the SPD on the DIMM.

BIOS reads the values encoded in the SPD ROM through a system-specific interface. BIOS acquires DIMM configuration information, such as the amount of memory on each DIMM, from the SPD ROM on each DIMM and uses this information to program the DRAM controller registers.

For solder-down DRAM, in the absence of an SPD ROM, BIOS provides the information necessary for DRAM configuration.

The SPD ROM provides values for several DRAM timing parameters that are required by the DCT. In general, BIOS should use the optimal value specified by the SPD ROM.

For [Ddr3Mode](#), these parameters are:

- D18F2x84\_dct[3:0][Twr]: Write recovery time
- D18F2x8C\_dct[3:0][Tref]
- D18F2x200\_dct[3:0]\_mp[1:0][Tras]: Active to precharge time
- D18F2x200\_dct[3:0]\_mp[1:0][Trp]: Precharge time
- D18F2x200\_dct[3:0]\_mp[1:0][Tred]: RAS to CAS delay
- D18F2x200\_dct[3:0]\_mp[1:0][Tcl]: CAS latency
- D18F2x204\_dct[3:0]\_mp[1:0][Trtp]: Internal read to precharge command delay time

- [D18F2x204\\_dct\[3:0\]\\_mp\[1:0\]\[FourActWindow\]](#): Four activate window delay time
- [D18F2x204\\_dct\[3:0\]\\_mp\[1:0\]\[Trrd\]](#): Row active to row active delay
- [D18F2x204\\_dct\[3:0\]\\_mp\[1:0\]\[Trc\]](#): Active to active/refresh time
- [D18F2x208\\_dct\[3:0\]\[Trfc3, Trfc2, Trfc1, Trfc0\]](#): Refresh recovery delay time
- [D18F2x20C\\_dct\[3:0\]\\_mp\[1:0\]\[Twtr\]](#): Internal write to read command delay time

Optimal cycle time is specified for each DIMM and is used to limit or determine bus frequency. See [2.9.9.5 \[DRAM Device Initialization and Training\]](#).

### 2.9.9.3.1 DRAM ODT Pin Control

This section applies to [Ddr3Mode](#) only.

BIOS configures the DIMM ODT behavior per chip select according to the DIMM population. In all cases, the processor ODT is off for writes and is on for reads. The ODT pin patterns for reads and writes are programmed using [D18F2x\[234:230\]\\_dct\[3:0\]](#) and [D18F2x\[23C:238\]\\_dct\[3:0\]](#), respectively.

**Table 34: DDR3 DIMM ODT Pattern**

| DIMM0 <sup>1</sup>                                                                                                                                                                      | DIMM1 <sup>1</sup>    | <a href="#">D18F2x[234:230]_dct[3:0]</a> |            | <a href="#">D18F2x[23C:238]_dct[3:0]</a> |            |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|------------------------------------------|------------|------------------------------------------|------------|
|                                                                                                                                                                                         |                       | D18F2x230                                | D18F2x234  | D18F2x238                                | D18F2x23C  |
| -                                                                                                                                                                                       | <a href="#">SR</a>    | 0000_0000h                               | 0000_0000h | 0002_0000h                               | 0000_0000h |
| -                                                                                                                                                                                       | <a href="#">DR</a>    | 0000_0000h                               | 0000_0000h | 0208_0000h                               | 0000_0000h |
| <a href="#">SR</a>                                                                                                                                                                      | -                     | 0000_0000h                               | 0000_0000h | 0000_0001h                               | 0000_0000h |
| <a href="#">DR</a>                                                                                                                                                                      | -                     | 0000_0000h                               | 0000_0000h | 0000_0104h                               | 0000_0000h |
| <a href="#">SR/DR</a>                                                                                                                                                                   | <a href="#">SR/DR</a> | 0101_0202h                               | 0000_0000h | 0903_0603h                               | 0000_0000h |
| 1. DIMM0: MEMCSx[1:0], MEMODTx[2,0].<br>DIMM1: MEMCSx[3:2], MEMODTx[3,1].<br>Population restrictions may apply. See <a href="#">2.9.9.2.4 [DRAM CAD Bus Configuration]</a> for details. |                       |                                          |            |                                          |            |

### 2.9.9.4 DCT Specific Configuration

The DCT requires certain features be disabled during DRAM device initialization and training. BIOS should program the registers in [Table 35](#) before DRAM device initialization and training. For normal operation, BIOS programs the recommended values if provided in [Table 35](#). BIOS must quiesce all other forms of DRAM traffic on the channel being trained. See [2.9.9 \[DCT/DRAM Initialization and Resume\]](#).

**Table 35: DCT Training Specific Register Values**

| Register                                                        | Mode                     | Training | Normal Operation              |
|-----------------------------------------------------------------|--------------------------|----------|-------------------------------|
| <a href="#">D18F2x78_dct[3:0][GsyncDis]</a>                     | <a href="#">Ddr3Mode</a> | 0        | 0                             |
| <a href="#">D18F2x218_dct[3:0]_mp[1:0][TrdrdBan, TrdrdSdSc]</a> | <a href="#">Ddr3Mode</a> | {2h, 1h} | See <a href="#">2.9.9.4.1</a> |
| <a href="#">D18F2x218_dct[3:0]_mp[1:0][TrdrdSdDc, TrdrdDd]</a>  | <a href="#">Ddr3Mode</a> | {Bh, Bh} | See <a href="#">2.9.9.4.1</a> |
| <a href="#">D18F2x214_dct[3:0]_mp[1:0][TwrwrSdSc]</a>           | <a href="#">Ddr3Mode</a> | 1        | See <a href="#">2.9.9.4.1</a> |
| <a href="#">D18F2x214_dct[3:0]_mp[1:0][TwrwrSdDc, TwrwrDd]</a>  | <a href="#">Ddr3Mode</a> | {Bh, Bh} | See <a href="#">2.9.9.4.1</a> |



**Table 35: DCT Training Specific Register Values**

| Register                                                                | Mode     | Training | Normal Operation |
|-------------------------------------------------------------------------|----------|----------|------------------|
| D18F2x218_dct[3:0]_mp[1:0][Twrrd]                                       | Ddr3Mode | Bh       | See 2.9.9.4.1    |
| D18F2x21C_dct[3:0]_mp[1:0][TrwtTO]                                      | Ddr3Mode | 1Bh      | See 2.9.9.4.1    |
| D18F2x78_dct[3:0][AddrCmdTriEn]                                         | Ddr3Mode | 0        | 1                |
| D18F2x8C_dct[3:0][DisAutoRefresh]                                       | Ddr3Mode | 1        | 0                |
| D18F2x90_dct[3:0][ForceAutoPchg]                                        | Ddr3Mode | 0        | 0                |
| D18F2x90_dct[3:0][DynPageCloseEn]                                       | Ddr3Mode | 0        | 0                |
| D18F2x94_dct[3:0][BankSwizzleMode]                                      | Ddr3Mode | 0        | 1                |
| D18F2x94_dct[3:0][DcqBypassMax]                                         | Ddr3Mode | 0        | 1Fh              |
| D18F2x94_dct[3:0][PowerDownEn]                                          | Ddr3Mode | 0        | 1                |
| D18F2x94_dct[3:0][ZqcsInterval]                                         | Ddr3Mode | 00b      | 10b              |
| D18F2xA4[CmdThrottleMode]                                               | Ddr3Mode | 000b     | xxx <sup>1</sup> |
| D18F2xA4[ODTSEn]                                                        | Ddr3Mode | 0b       | x <sup>1</sup>   |
| D18F2xA4[BwCapEn]                                                       | Ddr3Mode | 0        | x <sup>1</sup>   |
| D18F2xA8_dct[3:0][BankSwap]                                             | Ddr3Mode | 0        | 1                |
| D18F1x2[1,0][C,4][DctIntLvEn]                                           | Ddr3Mode | 0        | x <sup>1</sup>   |
| 1. Programmed specific to the current platform or memory configuration. |          |          |                  |

#### 2.9.9.4.1 DDR3 Turnaround Parameters

This section and all of the following sub-sections apply to [Ddr3Mode](#) only.

- LD (latency difference) = D18F2x200\_dct[3:0]\_mp[1:0][Tcl] - D18F2x20C\_dct[3:0]\_mp[1:0][Tewl].
- WOD (Write ODT Delay) = MAX(0, D18F2x240\_dct[3:0]\_mp[1:0][WrOdtOnDuration] - 6).

In all cases, if the computed turn around time is less than the smallest non-reserved value in the register then software programs the smallest non-reserved value.

##### 2.9.9.4.1.1 TrdrdBan, TrdrdSdSc, TrdrdSdDc, and TrdrdDd (Rd->Rd Timing)

This section applies to [Ddr3Mode](#) only.

The optimal values for D18F2x218\_dct[3:0]\_mp[1:0][TrdrdBan, TrdrdSdSc, TrdrdSdDc, TrdrdDd] are platform and configuration specific and should be characterized for best performance. After DRAM training, BIOS should use the guidelines below to configure the recommended platform generic timing values:

- CD\_R\_R, CD\_R\_R\_SD, and Trdrdban\_Phy are obtained from the PMU via the [SRAMMsgBlk](#).
- TrdrdSdSc = 1.
- TrdrdSdDc = CD\_R\_R\_SD.
- TrdrdDd = CD\_R\_R.
- TrdrdBan = Trdrdban\_Phy.

##### 2.9.9.4.1.2 TwrwrSdSc, TwrwrSdDc, TwrwrDd (Wr->Wr Timing)

This section applies to [Ddr3Mode](#) only.

The optimal values for [D18F2x214\\_dct\[3:0\]\\_mp\[1:0\]](#)[TwrrwSdSc, TwrrwSdDc, TwrrwDd] are platform and configuration specific and should be characterized for best performance. After DRAM training, BIOS should use the guidelines below to configure the recommended platform generic timing values:

- CD\_W\_W and CD\_W\_W\_SD are obtained from the PMU via the [SRAMMsgBlk](#).
- TwrrwSdSc = 1.
- TwrrwSdDc = CD\_W\_W\_SD.
- TwrrwDd = CD\_W\_W.

#### 2.9.9.4.1.3 Twrrd (Write to Read DIMM Termination Turn-around)

This section applies to [Ddr3Mode](#) only.

The optimal value for [D18F2x218\\_dct\[3:0\]\\_mp\[1:0\]](#)[Twrrd] is platform and configuration specific and should be characterized for best performance. Prior to DRAM training, BIOS should program this parameter to the largest defined value. After DRAM training, BIOS should use the guidelines below to configure the recommended platform generic timing values:

- Twrrd = CD\_W\_R obtained from the PMU via the [SRAMMsgBlk](#).

#### 2.9.9.4.1.4 TrwtTO (Read-to-Write Turnaround for Data, DQS Contention)

This section applies to [Ddr3Mode](#) only.

The optimal value for [D18F2x21C\\_dct\[3:0\]\\_mp\[1:0\]](#)[TrwtTO] is platform and configuration specific and should be characterized for best performance. Prior to DRAM training, BIOS should program this parameter to the largest defined value. After DRAM training, BIOS should use the guidelines below to configure the recommended platform generic timing values after DDR training is complete:

- TrwtTO = CD\_R\_W obtained from the PMU via the [SRAMMsgBlk](#).

### 2.9.9.5 DRAM Device Initialization and Training

BIOS requests the PMU to initialize the bus and devices, as well as train the processor for optimal operation, using the SequenceCtl bitmap in [SRAMMsgBlk](#), and by taking the PMU out of reset to execute the requests.

In the following steps, BIOS performs each step for each DCT={[MaxDctMstr:0](#)}, keeping the PMUs in lock-step, before moving to the next step.

1. Perform the PMU firmware load for the module containing Devinit. See [2.9.9.2.9](#).
2. Program [SRAMMsgBlk](#) with all values necessary for Devinit. See [2.9.8.3](#).
3. Set [SRAMMsgBlk](#), field SequenceCtl = 0x7F for a single module solution, or set [SRAMMsgBlk](#), field SequenceCtl = 0x1F for a two module solution (see below).
4. Fence the CalOnce. See [2.9.9.2.8.2](#).
5. Program [D18F2x9C\\_x0002\\_0099\\_dct\[3:0\]](#)[PmuStall] = 0.
6. mboxUSPend(PMUQEmpty). See [2.9.8.1](#).
  - If message is FAIL then continue to step 7 for that DCT only; In keeping with the requirement above, begin next step only after all DCTs are ready.

7. Read [SRAMMsgBlk](#) and store for later use.

If the total firmware size makes it necessary to load and execute two firmware modules consecutively for complete boot then BIOS performs the following additional steps. BIOS performs each step for each DCT={[MaxDctMstr:0](#)}, keeping the PMUs in lockstep, before moving to the next step.

1. Program [D18F2x9C\\_x0002\\_0099\\_dct\[3:0\]\[PmuReset,PmuStall\]](#) = 1,1.
2. Program [D18F2x9C\\_x0002\\_0099\\_dct\[3:0\]\[PmuReset\]](#) = 0.
3. Perform the PMU firmware load for the module containing 2D Read Training. See [2.9.9.2.9](#).
  - [SRAMMsgBlk](#) values from first PMU execution should be preserved. Do not overwrite [SRAMMsgBlk](#).
4. Program [SRAMMsgBlk](#) with all values necessary for 2D Read Training. See [2.9.8.3](#).
5. Set [SRAMMsgBlk](#), field [SequenceCtl](#) = 0x60.
6. Program [D18F2x9C\\_x0002\\_0099\\_dct\[3:0\]\[PmuStall\]](#) = 0.
7. [mboxUSPend\(PMUQEmpty\)](#). See [2.9.8.1](#).

### 2.9.9.6 DRAM Training

The PMU trains the I/O timing and electrical parameters on the DDR bus. BIOS initiates the training using a command bitmap in the [SRAMMsgBlk](#) of each PMU, keeping each PMU in lockstep. See [2.9.9.5](#).

Once the I/O timing is trained, the BIOS trains the round trip data latency path from the controller through the channel and back to the northbridge. See [2.9.9.6.1](#).

#### 2.9.9.6.1 Training MaxRdLatency

After DRAM training, BIOS optimizes [D18F2x210\\_dct\[3:0\]\\_nbp\[3:0\]\[MaxRdLatency\]](#) using the following algorithm. For MaxRdLatency training, BIOS generates a training pattern using continuous read or write data streams. See [2.9.10.1 \[DCT Training Pattern Generation\]](#).

For each DCT={[MaxDct:0](#)}:

1. Calculate a starting MaxRdLatency delay value by converting [Tcl](#) to NCLKs. See [D18F2x200\\_dct\[3:0\]\\_mp\[1:0\]\[Tcl\]](#).
2. Select 32 64-byte aligned test addresses associated with the chipselect that has the worst case round trip delay ([D18F2x9C\\_x0\[F,1:0\]\[F,8:0\]1\\_\[F,9:0\]\[F,3:0\]80\\_dct\[3:0\]\[RxDly\]](#) (for a DQ pad) + [D18F2x9C\\_x0\[F,1:0\]\[F,8:0\]1\\_\[F,9:0\]\[F,3:0\]80\\_dct\[3:0\]\[RxDly\]](#) (for a DQS pad within the same bytelane as the DQ pad).
3. Write the DIMM test addresses with the training pattern.
4. For each MaxRdLatency value incrementing from the value calculated in step 1:
  - A. Program [D18F2x210\\_dct\[3:0\]\\_nbp\[3:0\]\[MaxRdLatency\]](#) with the current value.
  - B. Read the DIMM test addresses.
  - C. Compare the values read against the pattern written.
    - If the pattern is read correctly, go to step 5.
5. Program [D18F2x210\\_dct\[3:0\]\\_nbp\[3:0\]\[MaxRdLatency\]](#) = CEIL(current value + fudge factor).
  - NB P-state 0 fudge factor = 1 NCLK + 3 MEMCLK
  - NB P-state [3:1] fudge factor = 3 NCLK + 3 MEMCLK

### 2.9.9.7 Synchronous Channel Initialization

- BIOS ensures that the frequency is programmed in the DCT correctly prior to the channel initialization. See [D18F2x94\\_dct\[3:0\]\[MemClkFreq\]](#), [D18F2x2E0\\_dct\[3:0\]\[M1MemClkFreq\]](#).

- IF (Ddr3Mode) then BIOS programs DCT specific read pointer initial values as specified in step 2 of 2.9.9.2.6 [Phy FIFO Configuration] prior to the channel initialization.

1. IF resuming from an S3 system state and the DRAMs are in self-refresh, then
  - Program D18F2x9C\_x00FF\_000D\_dct[3:0][PhyClkCtl]= 1.
2. Program D18F2x78\_dct[3:0][PtrInitReq]=1. Wait for D18F2x78\_dct[3:0][PtrInitReq]==0.

### 2.9.9.8 DRAM Channel Disable

The following steps are performed to disable an unused DRAM channel:

1. Program D18F2x9C\_x03FF\_F041\_dct[3:0]=0000\_0000h.
  - See D18F2x9C\_x0[3,1:0][F,3:0]0\_[F,B:0]041\_dct[3:0], and D18F2x9C\_x0[3,1:0][F,8:0]1\_[F,B:0]041\_dct[3:0].
2. Program D18F2x9C\_x00FA\_F04A\_dct[] = 0080h.
  - See D18F2x9C\_x00[F,3:0]0\_[F,B:0]04A\_dct[3:0] and D18F2x9C\_x0009\_004A\_dct[3:0].
3. Program D18F2x9C\_x0002\_000B\_dct[3:0] = 0000\_0004h.
4. Ensure that D18F2x78\_dct[3:0][ChanVal] = 0.
5. Ensure that D18F2x90\_dct[3:0][DisDllShutdownSR] = 1.
6. Program D18F2x94\_dct[3:0][DisDramInterface] = 1.

If a DCT does not exist then these steps must be skipped.

### 2.9.9.9 DRAM Phy Power Savings

For power savings, BIOS should perform the following actions for each enabled channel:

1. Program D18F2x9C\_x0[3,1:0][F,3:0]0\_[F,B:0]041\_dct[3:0] as follows to disable unused pads.
  - DrvStrenN = DrvStrenP = 0.
  - See 2.9.4. Software does this for each unconnected pad in the package or each pad connected to unused pin(s).
2. Program D18F2x9C\_x0[3,1:0][F,3:0]0\_0014\_dct[3:0][MaxDurDllNoLock] = 0.
3. Program D18F2x9C\_x0[3,1:0][F,8:0]1\_0014\_dct[3:0][MaxDurDllNoLock,DllPumpPeriod] as follows:
  - If (DDR rate <= 1067) MaxDurDllNoLock = 9h
  - else MaxDurDllNoLock = 7h
  - DllPumpPeriod = 3h
4. Program D18F2x9C\_x0[3,1:0][F,8:0]1\_[F,B:0]04D\_dct[3:0] as follows:
  - For M1 context program ODTStrenN = ODTStrenP = 0.
5. Program D18F2x9C\_x01F1\_F043\_dct[3:0] = 0004h.
  - See D18F2x9C\_x0[3,1:0][F,8:0]1\_[F,7:0]043\_dct[3:0].
6. Program D18F2x9C\_x00FA\_F04A\_dct[] = 0080h.
  - See D18F2x9C\_x00[F,3:0]0\_[F,B:0]04A\_dct[3:0] and D18F2x9C\_x0009\_004A\_dct[3:0].
7. Power down unused DBYTE 9 (undocumented spare) as follows:
  - Program D18F2x9C\_x0091\_F04A\_dct[] = 0280h.
  - Program D18F2x9C\_x0091\_0F77\_dct[] = 07CFh.
  - Program D18F2x9C\_x0091\_0000\_dct[] = 00004.
  - Program D18F2x9C\_x0091\_0F77\_dct[] = 07DFh.
  - Program D18F2x9C\_x0391\_F04D\_dct[] = 0000h.

- Program D18F2x9C\_x0391\_F041\_dct[] = 0000h.
8. Disable unused DLL components in ABYTE as follows:
    - Program D18F2x9C\_x0020\_0077\_dct[] = 07C0h.
    - Program D18F2x9C\_x0030\_0077\_dct[] = 07C0h.
    - Program D18F2x9C\_x0000\_0077\_dct[] = 07C4h.
    - Program D18F2x9C\_x0010\_0077\_dct[] = 07C4h.
    - See [D18F2x9C\\_x00\[F,3:0\]0\\_0077\\_dct\[3:0\]](#)
  9. If ECC memory is not connected or is disabled, or the package does not support ECC, then power down data chiplet 8 with the following:
    - Write to all memory P-state instances if available.
    - Program [D18F2x9C\\_x00\[F,8:0\]1\\_\[F,B:0\]04A\\_dct\[3:0\]](#) = 0280h.
    - Program [D18F2x9C\\_x00\[F,8:0\]1\\_0\[F,2:0\]77\\_dct\[3:0\]](#) = 07CFh.
    - Program [D18F2x9C\\_x00\[F,8:0\]1\\_0000\\_dct\[3:0\]](#) = 00004.
    - Program [D18F2x9C\\_x00\[F,8:0\]1\\_0\[F,2:0\]77\\_dct\[3:0\]](#) = 07DFh.
    - Program [D18F2x9C\\_x0\[3,1:0\]\[F,8:0\]1\\_\[F,B:0\]04D\\_dct\[3:0\]](#) = 0000h.
    - Program [D18F2x9C\\_x0\[3,1:0\]\[F,8:0\]1\\_\[F,B:0\]041\\_dct\[3:0\]](#) = 0000h.
  10. Power down unused receivers in data chips as follows:
    - Program D18F2x9C\_x00F1\_804A\_dct[] = 280h.
    - Program D18F2x9C\_x00F1\_904A\_dct[] = 280h.
    - If x4 DIMMs are not present then program D18F2x9C\_x00F1\_B04A\_dct[] = 280h.
    - See [D18F2x9C\\_x00\[F,8:0\]1\\_\[F,B:0\]04A\\_dct\[3:0\]](#)
  11. Power down the PMU as follows:
    - Program [D18F2x9C\\_x0002\\_0099\\_dct\[3:0\]\[PmuReset,PmuStall\]](#) = {1,1}.
    - Program [D18F2x9C\\_x0002\\_0099\\_dct\[3:0\]\[SRAM\\_SD\]](#) = 1.
    - For M0 context program [D18F2x9C\\_x0\[1:0\]02\\_0080\\_dct\[3:0\]\[PMUClkDiv\]](#) = 7.

## 2.9.10 Continuous Pattern Generation

DRAM training relies on the ability to generate a string of continuous reads or writes between the processor and DRAM, such that worst case electrical interactions can be created. This section describes how these continuous strings of accesses may be generated.

### 2.9.10.1 DCT Training Pattern Generation

DCT training pattern generation uses pattern generators in the DCT to generate controlled read and write traffic streams. During write pattern generation, data values based off of a deterministic pattern are burst to the DRAM interface. Conversely for reads, data bursts from the DRAM interface are compared against expected data values on a per nibble basis.

Two address modes are available for DRAM training pattern generation, as configured by [D18F2x250\\_dct\[3:0\]\[CmdTgt\]](#). For generating a stream of reads or writes to the same rank, address target A mode is used. To generate a stream of accesses to up to two different ranks, address target A and B mode is used.

An overview of the BIOS sequence to generate training patterns is as follows:

- Configure the DCT for pattern generation. See [2.9.9.4 \[DCT Specific Configuration\]](#).
- Ensure DIMMs are configured to support 8-beat bursts (BL8 or dynamic burst length on the fly).
- Wait for [D18F2x250\\_dct\[3:0\]\[CmdSendInProg\]](#) = 0.
- Program [D18F2x250\\_dct\[3:0\]\[CmdTestEnable\]](#) = 1.
- Send activate commands as appropriate. See [2.9.10.1.1 \[Activate and Precharge Command Generation\]](#).
- Send read or write commands as desired. See [2.9.10.1.2 \[Read and Write Command Generation\]](#).
- Send precharge commands as appropriate. See [2.9.10.1.1 \[Activate and Precharge Command Generation\]](#).
- Program [D18F2x250\\_dct\[3:0\]\[CmdTestEnable\]](#) = 0.

#### 2.9.10.1.1 Activate and Precharge Command Generation

Prior to sending read or write commands, BIOS must send an activate command to a row in a particular bank of the DRAM devices for access. To send an activate command, BIOS performs the following steps:

- Program [D18F2x28C\\_dct\[3:0\]](#) to the desired address as follows:
  - [CmdChipSelect](#) = [CS\[7:0\]](#).
  - [CmdBank](#) = [BA\[2:0\]](#).
  - [CmdAddress](#) = [A\[17:0\]](#).
- Program [D18F2x28C\\_dct\[3:0\]\[SendActCmd\]](#) = 1.
- Wait until [D18F2x28C\\_dct\[3:0\]\[SendActCmd\]](#) = 0.
- Wait 75 MEMCLKs.

After completing its accesses, BIOS must deactivate open rows in the DRAM devices. To send a precharge or precharge all command to deactivate open rows in a bank or in all banks, BIOS performs the following steps:

- Wait 25 MEMCLKs.
- Program [D18F2x28C\\_dct\[3:0\]](#) to the desired address as follows:
  - [CmdChipSelect](#) = [CS\[7:0\]](#).
  - Precharge all command:
    - [CmdAddress\[10\]](#) = 1.
  - Precharge command:
    - [CmdAddress\[10\]](#) = 0.
    - [CmdBank](#) = [BA\[2:0\]](#).

- Program `D18F2x28C_dct[3:0][SendPchgCmd]` = 1.
- Wait until `D18F2x28C_dct[3:0][SendPchgCmd]` = 0.
- Wait 25 MEMCLKs.

### 2.9.10.1.2 Read and Write Command Generation

BIOS performs the following steps for read pattern generation:

- Program `D18F2x27C_dct[3:0]`, `D18F2x278_dct[3:0]`, and `D18F2x274_dct[3:0]` with the data comparison masks for bit lanes of interest.
- Program `D18F2x270_dct[3:0][DataPrbsSeed]` the seed for the desired PRBS.
- Program `D18F2x260_dct[3:0][CmdCount]` equal to the number of cache line commands.
- Program `D18F2x25C_dct[3:0][BubbleCnt, CmdStreamLen]`. See 2.9.10.1.4 [BubbleCnt and CmdStreamLen Programming].
- Program `D18F2x25[8,4]_dct[3:0]` to the initial address.
- Program `D18F2x250_dct[3:0]` as follows:
  - ResetAllErr and StopOnErr as desired. See 2.9.10.1.3 [Data Comparison].
  - CmdTgt corresponding to `D18F2x25[8,4]_dct[3:0]`.
  - CmdType = 000b.
  - SendCmd = 1.
- If `D18F2x260_dct[3:0][CmdCount] != 0` then
  - Wait for `D18F2x250_dct[3:0][TestStatus] = 1` and `D18F2x250_dct[3:0][CmdSendInProg] = 0`.
  - Else
    - Wait the desired amount of time.
    - Program `D18F2x260_dct[3:0][CmdCount] = 1`.
    - Wait for `D18F2x250_dct[3:0][TestStatus] = 1` and `D18F2x250_dct[3:0][CmdSendInProg] = 0`.
- Program `D18F2x250_dct[3:0][SendCmd] = 0`.
- Read `D18F2x264_dct[3:0]`, `D18F2x268_dct[3:0]`, and `D18F2x26C_dct[3:0]` if applicable.

BIOS performs the following steps for write pattern generation:

- Program `D18F2x270_dct[3:0][DataPrbsSeed]` the seed for the desired PRBS.
- Program `D18F2x260_dct[3:0][CmdCount]` equal to the number of cache line commands desired.
- Program `D18F2x25C_dct[3:0][BubbleCnt, CmdStreamLen]`. See 2.9.10.1.4 [BubbleCnt and CmdStreamLen Programming].
- Program `D18F2x25[8,4]_dct[3:0]` to the initial address.
- Program `D18F2x250_dct[3:0]` as follows:
  - CmdTgt corresponding to `D18F2x25[8,4]_dct[3:0]`.
  - CmdType = 001b.
  - SendCmd = 1.
- If `D18F2x260_dct[3:0][CmdCount] != 0` then
  - Wait for `D18F2x250_dct[3:0][TestStatus] = 1` and `D18F2x250_dct[3:0][CmdSendInProg] = 0`.
  - Else
    - Wait the desired amount of time.
    - Program `D18F2x260_dct[3:0][CmdCount] = 1`.
    - Wait for `D18F2x250_dct[3:0][TestStatus] = 1` and `D18F2x250_dct[3:0][CmdSendInProg] = 0`.
- Program `D18F2x250_dct[3:0][SendCmd] = 0`.

BIOS combines the two sets of steps listed above for alternating write and read pattern generation.



### 2.9.10.1.3 Data Comparison

The DCT compares the incoming read data against the expected pattern sequence during pattern generation. BIOS may choose to continue command generation and accumulate errors or stop command generation on the first error occurrence by programming [D18F2x250\\_dct\[3:0\]\[StopOnErr\]](#).

Error information is reported via [D18F2x264\\_dct\[3:0\]](#), [D18F2x268\\_dct\[3:0\]](#), [D18F2x26C\\_dct\[3:0\]](#), [D18F2x294\\_dct\[3:0\]](#), [D18F2x298\\_dct\[3:0\]](#) and [D18F2x29C\\_dct\[3:0\]](#). Error information can be masked on per-bit basis by programming [D18F2x274\\_dct\[3:0\]](#), [D18F2x278\\_dct\[3:0\]](#), and [D18F2x27C\\_dct\[3:0\]](#).

BIOS resets the error information by programming [D18F2x250\\_dct\[3:0\]\[ResetAllErr\]](#)=1.

Error information is only valid in certain modes of [D18F2x250\\_dct\[3:0\]\[CmdType, CmdTgt\]](#) and [D18F2x260\\_dct\[3:0\]\[CmdCount\]](#) and when using 64 byte aligned addresses in [D18F2x25\[8,4\]\\_dct\[3:0\]\[TgtAddress\]](#). Some modes require a series of writes to setup a DRAM data pattern. See [Table 36](#).

**Table 36. Command Generation and Data Comparison**

| Commands   | CmdType | Cmd Tgt          | Maximum CmdCount <sup>4</sup> |
|------------|---------|------------------|-------------------------------|
| Read       | 000b    | 00b <sup>1</sup> | 128                           |
|            |         | 01b <sup>1</sup> | 256 <sup>2</sup>              |
| Write-Read | 010b    | 00b              | Infinite                      |
|            |         | 01b <sup>3</sup> | 256 <sup>2</sup>              |

1. Requires setup writes to store a data pattern in DRAM. The write commands are generated using the same CmdTgt, CmdCount, and DataPrbsSeed settings.
2. D18F2x254[TgtAddress] != D18F2x258[TgtAddress].
3. Requires setup writes to store a data pattern in DRAM. The write commands are generated programming D18F2x254[TgtAddress] to the intended Target B, CmdTgt=00b, CmdCount to 1/2 of the intended command count, and the same DataPrbsSeed setting.
4. D18F2x250\_dct[3:0][LsfrRollOver]=0. The maximum CmdCount is infinite for all modes listed if D18F2x250\_dct[3:0][LsfrRollOver]=1.

### 2.9.10.1.4 BubbleCnt and CmdStreamLen Programming

BIOS programs [D18F2x25C\\_dct\[3:0\]\[BubbleCnt2, BubbleCnt, CmdStreamLen\]](#) to ensure proper channel command spacing in command generation mode.

For continuous pattern generation it is expected that BubbleCnt = 0. In other modes, BIOS programs BubbleCnt, BubbleCnt2, and CmdStreamLen greater than or equal to the relevant DRAM timing parameters shown below to prevent contention on the DRAM bus. In all cases, if the minimum BubbleCnt > 0 or CmdType = 010b then BIOS programs CmdStreamLen = 1.



**Table 37. DDR3 Command Generation and BubbleCnt Programming**

| Commands                   | CmdType | CmdTgt | BubbleCnt                                                                                                  | BubbleCnt2                             |
|----------------------------|---------|--------|------------------------------------------------------------------------------------------------------------|----------------------------------------|
| Read-Read same CS          | 000b    | 0xb    | D18F2x218_dct[3:0]_mp[1:0][TrdrdSdSc] - 1; Exclude banned spacing:<br>D18F2x218_dct[3:0]_mp[1:0][TrdrdBan] | xh                                     |
| Write-Write same CS        | 001b    | 0xb    | D18F2x214_dct[3:0]_mp[1:0][TwrwrSdSc] - 1                                                                  | xh                                     |
| Write-Read same CS         | 010b    | 00b    | D18F2x20C_dct[3:0]_mp[1:0][Twtr] +<br>D18F2x20C_dct[3:0]_mp[1:0][Tcwl] + 4 - 1                             | D18F2x21C_dct[3:0]_mp[1:0][TrwtTO] - 1 |
| Read-Read different CS     | 000b    | 01b    | D18F2x218_dct[3:0]_mp[1:0][TrdrdSdDc] - 1; Exclude banned spacing:<br>D18F2x218_dct[3:0]_mp[1:0][TrdrdBan] | xh                                     |
| Write-Write different CS   | 001b    | 01b    | D18F2x214_dct[3:0]_mp[1:0][TwrwrSdDc] - 1                                                                  | xh                                     |
| Write-Read different CS    | 010b    | 01b    | D18F2x218_dct[3:0]_mp[1:0][Twrrd] - 1                                                                      | D18F2x21C_dct[3:0]_mp[1:0][TrwtTO] - 1 |
| Read-Read different DIMM   | 000b    | 01b    | D18F2x218_dct[3:0]_mp[1:0][TrdrdDd] - 1; Exclude banned spacing:<br>D18F2x218_dct[3:0]_mp[1:0][TrdrdBan]   | xh                                     |
| Write-Write different DIMM | 001b    | 01b    | D18F2x214_dct[3:0]_mp[1:0][TwrwrDd] - 1                                                                    | xh                                     |
| Write-Read different DIMM  | 010b    | 01b    | D18F2x218_dct[3:0]_mp[1:0][Twrrd] - 1                                                                      | D18F2x21C_dct[3:0]_mp[1:0][TrwtTO] - 1 |

### 2.9.11 Memory Interleaving Modes

The processor supports the following memory interleaving modes:

- Chip select: interleaves the physical address space over multiple DIMM ranks on a channel, as opposed to each DIMM owning single consecutive address spaces. See 2.9.11.1 [Chip Select Interleaving].
- Channel: interleaves the physical address space over multiple channels, as opposed to each channel owning single consecutive address spaces. See 2.9.11.2 [Channel Interleaving].

Any combination of these interleaving modes may be enabled concurrently.

**Table 38. Recommended Interleave Configurations**

| Interleaving Mode                                                        | Enabled                                                                                                              | Disabled                                                                                                         |
|--------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------|
| Chip Select Interleaving                                                 | Number of chip selects installed on the channel is a power of two.                                                   | Requirements not satisfied.                                                                                      |
| Channel Interleaving                                                     | DIMMs are present on a power of two number of channels.                                                              | Requirements not satisfied.                                                                                      |
| Interleave Region Remapping <sup>1</sup>                                 | UMA and DIMMs are present on a power of two number of channels and the channels do not have the same amount of DRAM. | ~UMA or all channels have the same amount of DRAM or DIMMs are not present on a power of two number of channels. |
| 1. The channel interleave region should always include the frame buffer. |                                                                                                                      |                                                                                                                  |

**2.9.11.1 Chip Select Interleaving**

The chip select memory interleaving mode has the following requirements:

- The number of chip selects interleaved is a power of two.
- The chip selects are the same size and type.

A BIOS algorithm for programming [D18F2x\[5C:40\]\\_dct\[3:0\] \[DRAM CS Base Address\]](#) and [D18F2x\[6C:60\]\\_dct\[3:0\] \[DRAM CS Mask\]](#) in memory interleaving mode is as follows:

- 1.Program all DRAM CS Base Address and DRAM CS Mask registers using contiguous normalized address mapping.
- 2.For each enabled chip select, swap the corresponding BaseAddr[38:27] bits with the BaseAddr[21:11] bits as defined in [Table 39](#).
- 3.For each enabled chip select, swap the corresponding AddrMask[38:27] bits with the AddrMask[21:11] bits as defined in [Table 39](#).

**Table 39. DDR3 Swapped Normalized Address Lines for CS Interleaving**

| DIMM Address Map <sup>1</sup> | Chip Select Size | (BankSwap, BankSwapLoAddress) <sup>2</sup> | Swapped Base Address and Address Mask bits |                       |
|-------------------------------|------------------|--------------------------------------------|--------------------------------------------|-----------------------|
|                               |                  |                                            | 4 way CS interleaving                      | 2 way CS interleaving |
| 0001b                         | 256-MB           | 0b,N/A                                     | [29:28] and [17:16]                        | [28] and [16]         |
|                               |                  | 1b,8                                       | [29:28] and [12:11]                        | [28] and [11]         |
|                               |                  | 1b,9                                       | [29:28] and [13:12]                        | [28] and [12]         |
| 0010b                         | 512-MB           | 0b,N/A                                     | [30:29] and [17:16]                        | [29] and [16]         |
|                               |                  | 1b,8                                       | [30:29] and [12:11]                        | [29] and [11]         |
|                               |                  | 1b,9                                       | [30:29] and [13:12]                        | [29] and [12]         |
| 0101b                         | 1-GB             | 0b,N/A                                     | [31:30] and [17:16]                        | [30] and [16]         |
|                               |                  | 1b,8                                       | [31:30] and [12:11]                        | [30] and [11]         |
|                               |                  | 1b,9                                       | [31:30] and [13:12]                        | [30] and [12]         |
| 0110b                         | 1-GB             |                                            | [31:30] and [18:17]                        | [30] and [17]         |

**Table 39. DDR3 Swapped Normalized Address Lines for CS Interleaving**

| DIMM Address Map <sup>1</sup>                                                                                                                                                                                                                                                                                                                            | Chip Select Size  | (BankSwap, BankSwapLoAddress) <sup>2</sup> | Swapped Base Address and Address Mask bits |                       |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|--------------------------------------------|--------------------------------------------|-----------------------|
|                                                                                                                                                                                                                                                                                                                                                          |                   |                                            | 4 way CS interleaving                      | 2 way CS interleaving |
| 0111b                                                                                                                                                                                                                                                                                                                                                    | 2-GB              | 0b,N/A                                     | [32:31] and [17:16]                        | [31] and [16]         |
|                                                                                                                                                                                                                                                                                                                                                          |                   | 1b,8                                       | [32:31] and [12:11]                        | [31] and [11]         |
|                                                                                                                                                                                                                                                                                                                                                          |                   | 1b,9                                       | [32:31] and [13:12]                        | [31] and [12]         |
| 1000b                                                                                                                                                                                                                                                                                                                                                    | 2-GB, 4-GB, 8-GB  |                                            | [32:31] and [18:17]                        | [31] and [17]         |
| 1001b                                                                                                                                                                                                                                                                                                                                                    | 4-GB, 8-GB, 16-GB |                                            | [33:32] and [18:17]                        | [32] and [17]         |
| 1010b                                                                                                                                                                                                                                                                                                                                                    | 4-GB              | 0b,N/A                                     | [33:32] and [17:16]                        | [32] and [16]         |
|                                                                                                                                                                                                                                                                                                                                                          |                   | 1b,8                                       | [33:32] and [12:11]                        | [32] and [11]         |
|                                                                                                                                                                                                                                                                                                                                                          |                   | 1b,9                                       | [33:32] and [13:12]                        | [32] and [12]         |
| 1011b                                                                                                                                                                                                                                                                                                                                                    | 8-GB              | 0b,N/A                                     | [34:33] and [18:17]                        | [33] and [17]         |
|                                                                                                                                                                                                                                                                                                                                                          |                   | 1b,8                                       | [34:33] and [12:11]                        | [33] and [11]         |
|                                                                                                                                                                                                                                                                                                                                                          |                   | 1b,9                                       | [34:33] and [13:12]                        | [33] and [12]         |
| 1100b                                                                                                                                                                                                                                                                                                                                                    | 16-GB             |                                            | [35:34] and [19:18]                        | [34] and [18]         |
| <ol style="list-style-type: none"> <li>See <a href="#">D18F2x80_dct[3:0]</a> [DRAM Bank Address Mapping].</li> <li>See <a href="#">D18F2xA8_dct[3:0]</a>[BankSwap] and <a href="#">D18F2x110</a>[BankSwapAddr8En, DctSelIntLvAddr]. If BankSwapAddr8En==1 &amp;&amp; DctSelIntLvAddr==100b then BankSwapLoAddress=8 ELSE BankSwapLoAddress=9.</li> </ol> |                   |                                            |                                            |                       |

The following is an example of interleaving a 64-bit interface to DDR3 DRAM. The DRAM memory consists of two 512 MB dual rank DDR3 DIMMs.

- The register settings for contiguous memory mapping are:
  - [D18F2x80\\_dct\[3:0\]](#) = 0000\_0011h. // CS0/1 = 256 MB; CS2/3 = 256 MB
  - [D18F2x40](#) = 0000\_0001h. // 0 MB base
  - [D18F2x44](#) = 0010\_0001h. // 256 MB base = 0 MB + 256 MB
  - [D18F2x48](#) = 0020\_0001h. // 512 MB base = 256 MB + 256 MB
  - [D18F2x4C](#) = 0030\_0001h. // 768 MB base = 512 MB + 256 MB
  - [D18F2x60](#) = 0008\_FFE0h. // CS0/CS1 = 256 MB
  - [D18F2x64](#) = 0008\_FFE0h. // CS2/CS3 = 256 MB
- The base address bits to be swapped are defined in [Table 39](#), 256MB chip select size, 4 way CS interleaving column. The BaseAddr[29:28] bits are specified by [D18F2x\[5C:40\]\\_dct\[3:0\]\[21:20\]](#). The BaseAddr[17:16] bits are specified by [D18F2x\[5C:40\]\\_dct\[3:0\]\[11:10\]](#).
  - [D18F2x40](#) = 0000\_0001h.
  - [D18F2x44](#) = 0000\_0401h.
  - [D18F2x48](#) = 0000\_0801h.
  - [D18F2x4C](#) = 0000\_0C01h.
- The AddrMask bits to be swapped are the same as the BaseAddr bits defined in the previous step. The AddrMask[29:28] bits are specified by [D18F2x\[6C:60\]\\_dct\[3:0\]\[21:20\]](#). The AddrMask[17:16] bits are specified by [D18F2x\[6C:60\]\\_dct\[3:0\]\[11:10\]](#).
  - [D18F2x60](#) = 0038\_F3E0h.

- D18F2x64 = 0038\_F3E0h.
- 4. If BankSwap is enabled and DCT channel interleaving is enabled on system address bit 8, then the Base and AddrMask bits to be swapped are as follows:
  - D18F2x40 = 0000\_0001h.
  - D18F2x44 = 0000\_0021h.
  - D18F2x48 = 0000\_0041h.
  - D18F2x4C = 0000\_0061h.
  - D18F2x60 = 0038\_FF90h.
  - D18F2x64 = 0038\_FF90h.
- 5. If BankSwap is enabled and DCT channel interleaving is enabled on system address bit 9, then the Base and AddrMask bits to be swapped are as follows:
  - D18F2x40 = 0000\_0001h.
  - D18F2x44 = 0000\_0041h.
  - D18F2x48 = 0000\_0081h.
  - D18F2x4C = 0000\_00C1h.
  - D18F2x60 = 0038\_FF20h.
  - D18F2x64 = 0038\_FF20h.

### 2.9.11.2 Channel Interleaving

The channel memory interleaving mode requires that DIMMs are present on both channels. Channel interleaving is enabled by programming [D18F1x2\[1,0\]\[C,4\]\[DctIntLvEn\]](#) and [D18F2x110\[DctSelIntLvAddr\]](#) to specify how interleaving is performed among the DCTs. If the channels do not have the same amount of DRAM, [D18F1x2\[1,0\]\[8,0\]\[DctBaseAddr\]](#) and [D18F1x2\[1,0\]\[C,4\]\[DctLimitAddr\]](#) are used to configure the interleaved region. See also [2.9.12 \[Memory Hoisting\]](#).

#### 2.9.11.2.1 Four Channel Interleaving

Interleaving 4 DCTs requires one [D18F1x2\[1,0\]\[8,0\]\[DctBaseAddr\]](#) and [D18F1x2\[1,0\]\[C,4\]\[DctLimitAddr\]](#) pair to define the interleave region. [D18F1x2\[1,0\]\[C,4\]\[DctIntLvEn\]](#) is programmed to enable 4 DCTs and [D18F2x110\[DctSelIntLvAddr\]](#) determines the interleave addressing. See [2.9](#) for product specific limitations.

### 2.9.12 Memory Hoisting

Memory hoisting reclaims the otherwise inaccessible DRAM that would naturally reside in memory regions used by MMIO. When memory hoisting is configured by BIOS, DRAM physical addresses are repositioned above the 4 GB address level in the address map. In operation, the physical addresses are remapped in hardware to the normalized addresses used by a DCT.

The region of DRAM that is hoisted is defined to be from [D18F1xF0\[DramHoleBase\]](#) to the 4 GB level. Hoisting is enabled by programming [D18F1xF0 \[DRAM Hole Address\]](#) and configuring the DCTs per the equations in this section.

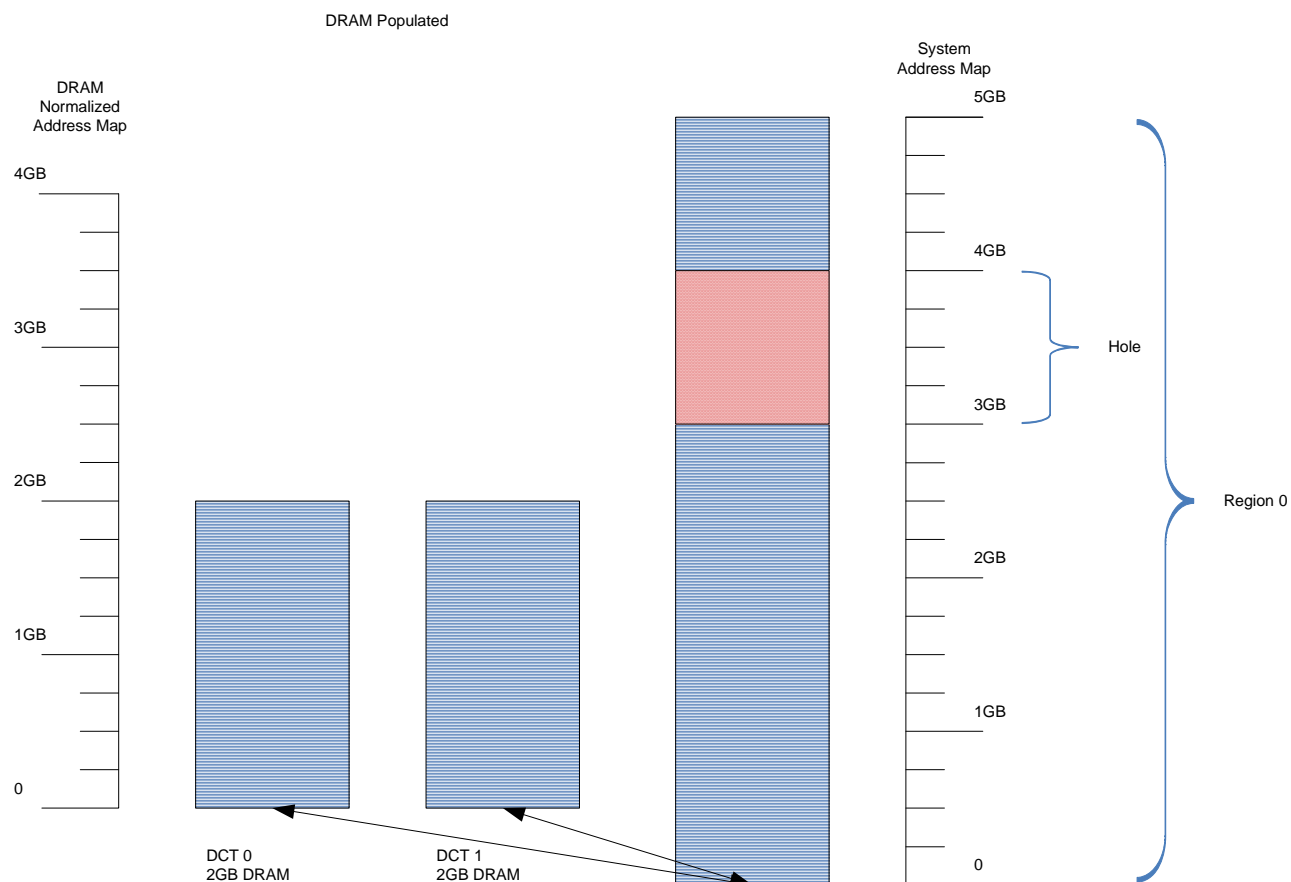
DramHoleSize is defined in order to simplify the following equations in this section and is calculated as follows:

- Define the DRAM hole region as  $\text{DramHoleSize}[31:24] = 100\text{h} - \text{D18F1xF0}[\text{DramHoleBase}[31:24]]$ .

#### 2.9.12.1 DramHoleOffset Programming

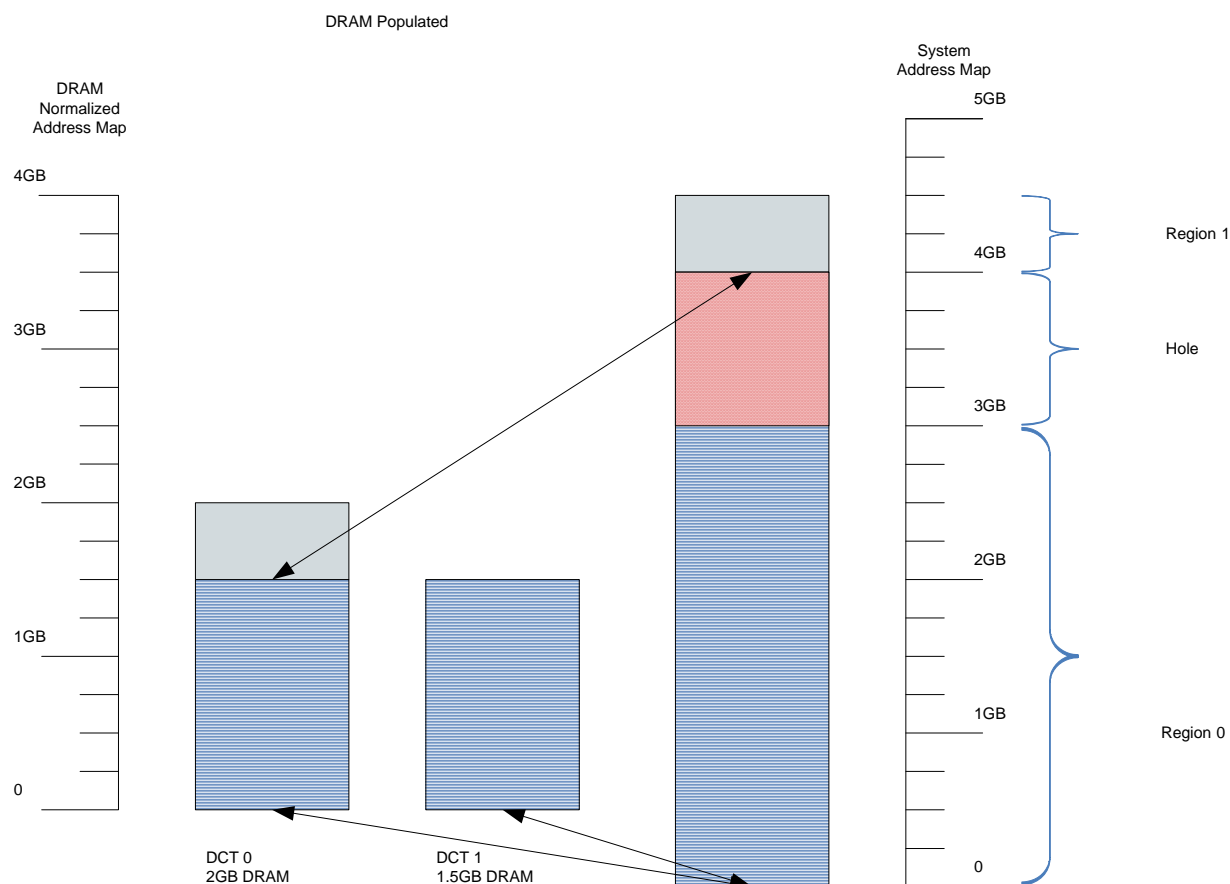
[D18F1xF0\[DramHoleOffset\]](#) is programmed to account for the addresses from [D18F1xF0\[DramHoleBase\]](#) to 4 GB when it falls inside of a [D18F1x2\[1,0\]\[8,0\]\[DctBaseAddr\]](#) and [D18F1x2\[1,0\]\[C,4\]\[DctLimitAddr\]](#) region. See [Figure 3](#) as an example memory population.

- Program `D18F1xF0[DramHoleOffset[31:23]] = {DramHoleSize[31:24], 0b} + {DctBaseAddr[31:27], 0000b};`



**Figure 3: Memory Configuration with Memory Hole inside of Region**

`D18F1xF0[DramHoleOffset]` is unused when the memory hole falls outside of a region. Figure 4 shows an example memory population which uses two memory regions. Region 1 is configured to begin above the memory hole.



**Figure 4: Memory Configuration with Memory Hole outside of Region**

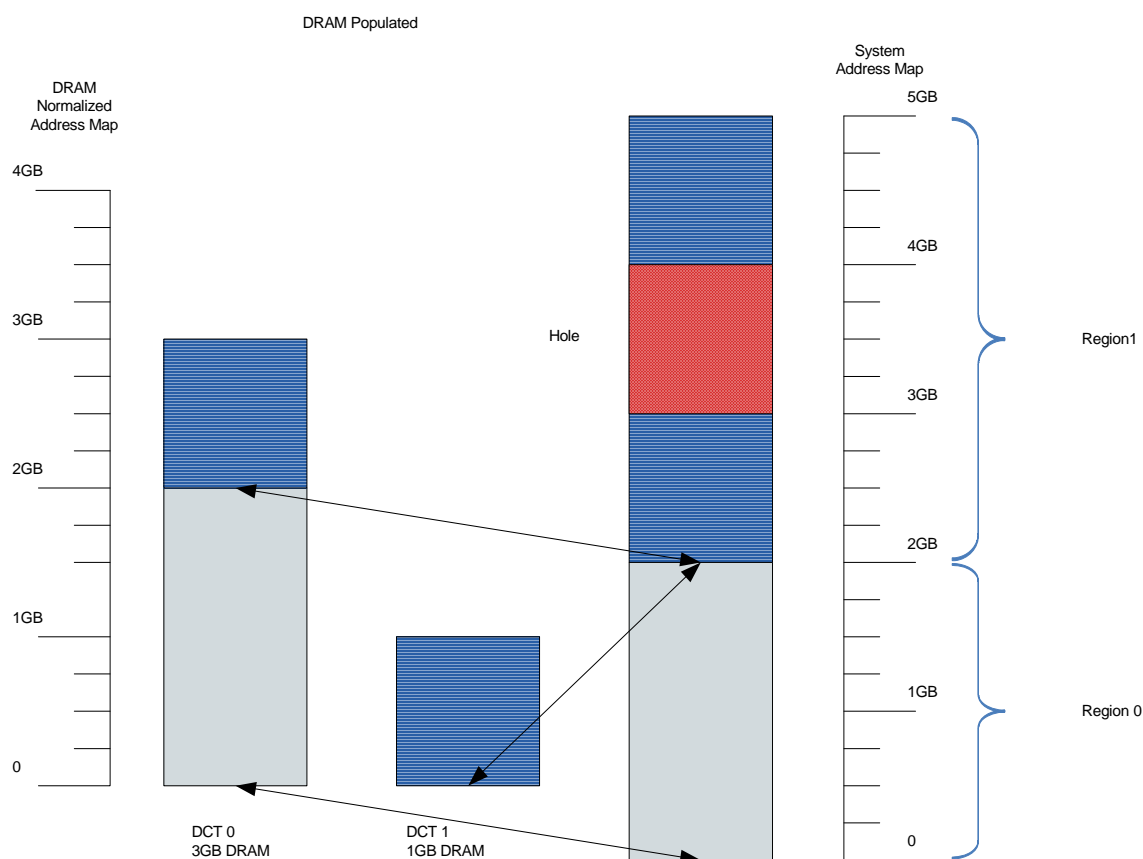
### 2.9.12.2 DctSelBaseOffset Programming

When a DCT is mapped by more than one `D18F1x2[1C:00]` region, `D18F1x2[1,0][8,0][DctOffsetEn]` `D18F1x2[4C:40][DctHighAddrOffset]` are programmed for the second region. In this case, an offset must be applied when forming the normalized address accounting for the DCT addresses mapped by the first region.

Program `D18F1x2[4C:40][DctHighAddrOffset[38:27]] = ((DctLimitAddr + 1) - DctBaseAddr - SizeOf(Memory Holes)) / ((D18F1x2[1,0][C,4][DctIntLvEn] > 0 ? POPCNT(D18F1x2[1,0][C,4][DctIntLvEn]) : 1).`

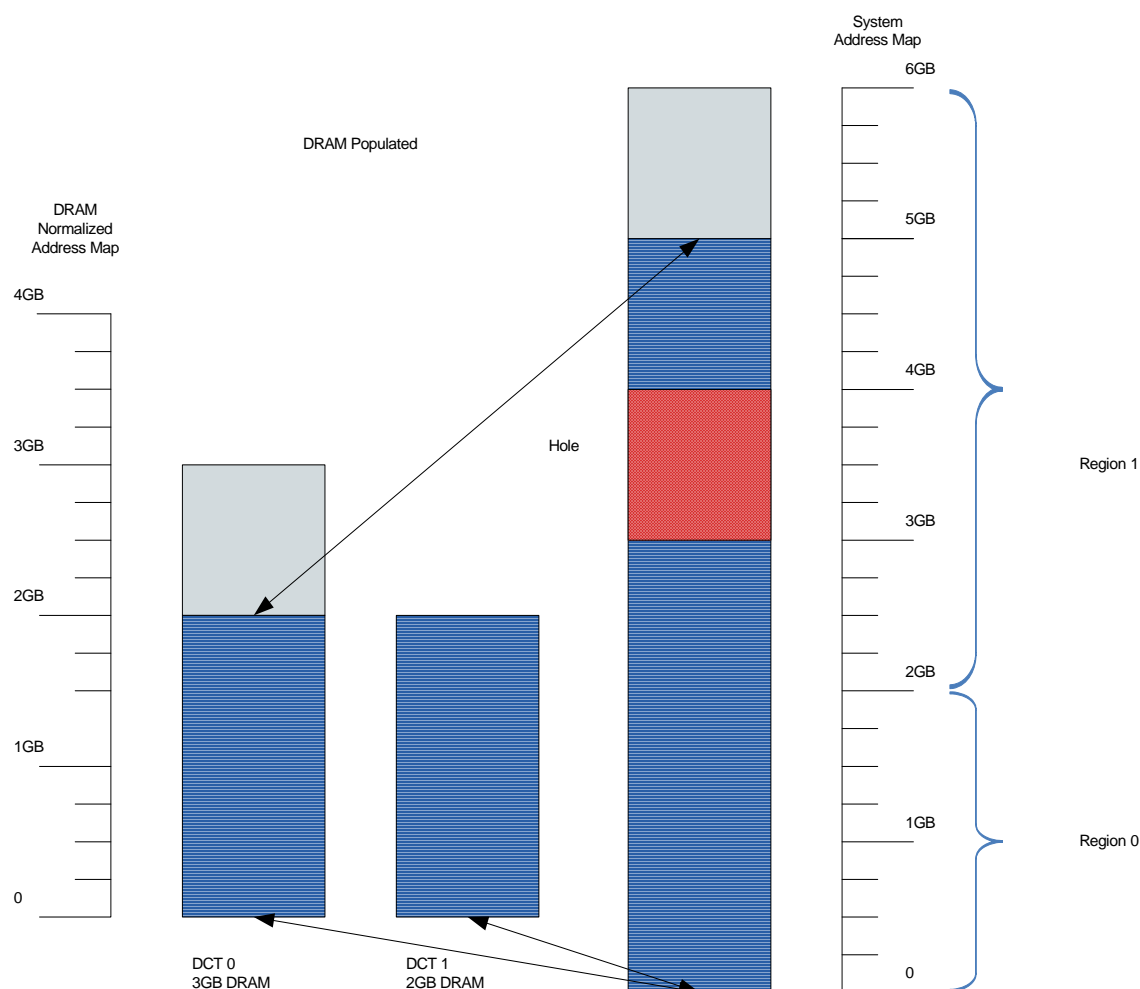
Examples:

- **Figure 5:** Region 0 maps addresses 0x0 thru 0x7FFF\_FFFF, offset Region 1 which is 2x channel interleaved.
  - `D18F1x208[DctOffsetEn] = 1.`
  - `D18F1x240[DctHighAddrOffset] = ((0x7FFF_FFFF + 1) - 0 - 0) / (1) = 2GB. //DCT 0 offset from Region 0.`
  - `D18F1x244[DctHighAddrOffset] = 0. //DCT 1 is not mapped by Region 0.`



**Figure 5: 2 DCT Channel Interleaved**

- **Figure 6:** Region 0 maps addresses 0x0 thru 0x1\_3FFF\_FFFF which is channel interleaved and contains a 1GB memory hole; offset Region 1 to map the remaining memory.
  - $D18F1x208[DctOffsetEn] = 1$ .
  - $D18F1x240[DctHighAddrOffset] = ((0x1\_3FFF\_FFFF + 1) - 0 - 0x4000\_0000)/(2) = 2GB$ . //DCT 0 offset from Region 0.



**Figure 6: 2 DCT Channel Interleaved with Memory Hole**

### 2.9.13 DRAM CC6/PC6 Storage

DRAM is used to hold the state information of cores entering the CC6 power management state. As part of the system setup if CC6 or PC6 is enabled, BIOS configures a special region of DRAM to hold the state information. In operation, hardware protects this region from general system accesses while allowing the cores access during C-state transitions.

#### 2.9.13.1 Fixed Storage

The size of each special DRAM storage region is defined to be a fixed 16MB. BIOS configures the storage region at the top of the DRAM range, adjusts [D18F1x\[7:4\]\[C,4\]\[DramLimit\]](#) and the processor top of DRAM specified by [MSRC001\\_001A\[TOM\]](#) or [MSRC001\\_001D\[TOM2\]](#) downward accordingly. See [Table 40](#).

After finalizing the system DRAM configuration, BIOS must set [D18F2x118\[LockDramCfg\]](#) = 1 to enable the hardware protection.



**Table 40. Example storage region configuration**

| Node | DRAM Populated | D18F1x[17C:140,7C:40]<br>[DramBase, DramLimit] | CC6<br>DRAM<br>Range  | D18F4x128<br>[CoreStateSa<br>veDestNode] | D18F1x120[DramBaseAddr],<br>D18F1x124[DramLimitAddr] |
|------|----------------|------------------------------------------------|-----------------------|------------------------------------------|------------------------------------------------------|
| 0    | 256 MB         | 0 MB,<br>240 MB - 1                            | 240 MB,<br>256 MB - 1 | 0                                        | 0 MB,<br>256 MB - 1                                  |

### 2.9.14 DRAM On DIMM Thermal Management and Power Capping

Each DCT can throttle commands based on the state of the channel EVENT\_L pin or when D18F2xA4[BwCapEn]=1. The EVENT\_L pin is used for thermal management while D18F2xA4[BwCapEn] limits memory power independent of the thermal management solution.

The EVENT\_L pin for each channel must be wire OR'ed. If all DCTs enabled throttle commands in lockstep using the amount specified in D18F2xA4[CmdThrottleMode] and D18F2xA4[BwCapCmdThrottleMode].

The recommended BIOS configuration for the EVENT\_L pin is as follows:

- BIOS may enable command throttling on a DRAM controller if the platform supports the EVENT\_L pin by programming D18F2xA4[ODTSEn] = 1.
  - The recommended usage is for this pin to be connected to one or more JEDEC defined on DIMM temperature sensors. The DIMM SPD ROM indicates on DIMM temperature sensor support.
  - BIOS configures the temperature sensor(s) to assert EVENT\_L pin active low when the trip point is exceeded and deassert EVENT\_L when the temperature drops below the trip point minus the sensor defined hysteresis.
  - BIOS programs D18F2xA4[CmdThrottleMode] with the throttling mode to employ when the trip point has been exceeded.
  - The hardware enforces a refresh rate of 3.9 us while EVENT\_L is asserted.
- BIOS configures D18F2x8C\_dct[3:0][Tref] based on JEDEC defined temperature range options, as indicated by the DIMM SPD ROM. The two defined temperature ranges are normal (with a case temperature of 85 °C) and extended (with a case temperature of 95 °C).
  - If all DIMMs support the normal temperature range, or if normal and extended temperature range DIMMs are mixed, BIOS programs D18F2x8C\_dct[3:0][Tref] to 7.8 us and D18F2xA4[ODTSEn] = 1. BIOS configures the temperature sensor trip point for all DIMMs according to the 85 °C case temperature specification.
  - If all DIMMs support the extended temperature range, BIOS has two options:
    - a. Follow the recommendation for normal temperature range DIMMs.
    - b. Program D18F2x8C\_dct[3:0][Tref] = 3.9 us and configure the temperature sensor trip point for all DIMMs according to the 95 °C case temperature specification.
- At startup, the BIOS determines if the DRAMs are hot before enabling a DCT and delays for an amount of time to allow the devices to cool under the influence of the thermal solution. This is accomplished by checking the temperature status in the temperature sensor of each DIMM.
- The DCT latched status of the EVENT\_L pin for can be read by system software in D18F2xAC [DRAM Controller Temperature Status].

The relationship between the DRAM case temperature, trip point, and EVENT\_L pin sampling interval is outlined as follows:

- The trip point for each DIMM is ordinarily configured to the case temperature specification minus a guard-band temperature for the DIMM.

- The temperature guardband is vendor defined and is used to account for sensor inaccuracy, EVENT\_L pin sample interval, and platform thermal design.
- The sampling interval is vendor defined. It is expected to be approximately 1 second.

BIOS may enable bandwidth capping on a DRAM controller by setting [D18F2xA4\[BwCapEn\]](#) = 1 and programming [D18F2xA4\[BwCapCmdThrottleMode\]](#) with the throttling mode to employ. The DCT will employ the larger of the two throttling percentages as specified by [D18F2xA4\[BwCapCmdThrottleMode\]](#) and [D18F2xA4\[CmdThrottleMode\]](#) if the EVENT\_L pin is asserted when both [D18F2xA4\[BwCapEn\]](#) = 1 and [D18F2xA4\[ODTSEn\]](#) = 1.

## 2.10 Thermal Functions

Thermal functions HTC, PROCHOT\_L and THERMTRIP are intended to maintain processor temperature in a valid range by:

- Providing a signal to external circuitry for system thermal management like fan control.
- Lowering power consumption by switching to lower-performance P-state.
- Sending processor to the THERMTRIP state to prevent it from damage.

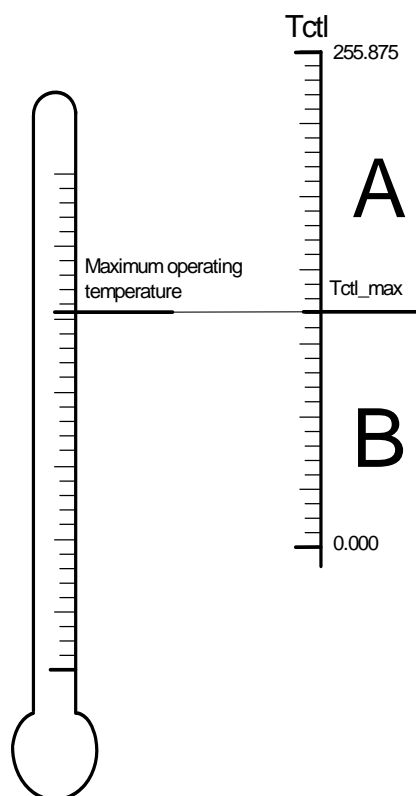
The processor thermal-related circuitry includes (1) the temperature calculation circuit (TCC) for determining the temperature of the processor and (2) logic that uses the temperature from the TCC.

### 2.10.1 The Tctl Temperature Scale

Tctl is a processor temperature control value used for processor thermal management. Tctl is accessible through [D18F3xA4\[CurTmp\]](#). Tctl is a temperature on its own scale aligned to the processors cooling requirements. Therefore Tctl does not represent a temperature which could be measured on the die or the case of the processor. Instead, it specifies the processor temperature relative to the maximum operating temperature, Tctl,max. Tctl,max is specified in the power and thermal data sheet. Tctl is defined as follows for all parts:

A: For  $Tctl = Tctl\_max$  to 255.875: the temperature of the part is  $[Tctl - Tctl\_max]$  over the maximum operating temperature. The processor may take corrective actions that affect performance, such as HTC, to support the return to Tctl range B.

B: For  $Tctl = 0$  to  $Tctl\_max - 0.125$ : the temperature of the part is  $[Tctl\_max - Tctl]$  under the maximum operating temperature.



**Figure 7: Tctl scale**

## 2.10.2 Temperature Slew Rate Control

The temperature slew rate controls in [D18F3xA4](#) are used to filter the processor temperature provided in [D18F3xA4\[CurTmp\]](#). Separate controls are provided for increasing and decreasing temperatures. The latest measured temperature is referred to as Tctlm below.

If downward slew control is enabled ([D18F3xA4\[TmpSlewDnEn\]](#)), Tctl is not updated down unless Tctlm remains below Tctl for a time specified by [D18F3xA4\[PerStepTimeDn\]](#). If at any point before the timer expires Tctlm equals or exceeds Tctl, then the timer resets and Tctl is not updated. If the timer expires, then Tctl is reduced by 0.125. If downward slew control is disabled, then if Tctlm is less than Tctl, Tctl is immediately updated to Tctlm.

The upward slew control works similar to downward slew control except that if Tctlm exceeds Tctl by a value defined by [D18F3xA4\[TmpMaxDiffUp\]](#) then Tctl is immediately updated to Tctlm. Otherwise, Tctlm must remain above Tctl for time specified by [D18F3xA4\[PerStepTimeUp\]](#) before Tctl is incremented by 0.125.

## 2.10.3 Temperature-Driven Logic

The temperature calculated by the TCC is used by HTC, THERMTRIP, and PROCHOT\_L.

### 2.10.3.1 PROCHOT\_L and Hardware Thermal Control (HTC)

The processor *HTC-active state* is characterized by (1) the assertion of PROCHOT\_L, (2) reduced power consumption, and (3) reduced performance. While in the HTC-active state, software should not change the following: All [D18F3x64](#) fields (except for HtcActSts and HtcEn), [MSRC001\\_001F\[DisProcHotPin\]](#). Any change to the previous list of fields when in the HTC-active state can result in undefined behavior. HTC status and control is provided through [D18F3x64](#).

The PROCHOT\_L pin acts as both an input and as an open-drain output. As an output, PROCHOT\_L is driven low to indicate that the HTC-active state has been entered due to an internal condition, as described by the following text. The minimum assertion and deassertion time for PROCHOT\_L is 200 us with a minimum period of 2 ms.

While in the HTC-active state, the following power reduction actions are taken:

- CPU cores are limited to a P-state (specified by [D18F3x64\[HtcPstateLimit\]](#)); see [2.5.3 \[CPU Power Management\]](#)
- The GPU may be placed in a low power state based on the state of [D18F5x178\[ProcHotToGnbEn\]](#)

The processor enters the HTC-active state if all of the following conditions are true:

- [D18F3xE8\[HtcCapable\]](#)=1
- [D18F3x64\[HtcEn\]](#)=1
- PWROK=1
- THERMTRIP\_L=1

and any of the following conditions are true:

- Tctl is greater than or equal to the HTC temperature limit ([D18F3x64\[HtcTmpLmt\]](#)).
- PROCHOT\_L=0

The processor exits the HTC-active state when all of the following are true:

- Tctl is less than the HTC temperature limit ([D18F3x64\[HtcTmpLmt\]](#)).
- Tctl has become less than the HTC temperature limit ([D18F3x64\[HtcTmpLmt\]](#)) minus the HTC hysteresis limit ([D18F3x64\[HtcHystLmt\]](#)) since being greater than or equal to the HTC temperature limit

- (D18F3x64[HtcTmpLmt]).
- PROCHOT\_L=1.

The default value of the HTC temperature threshold (Tctl\_max) is specified in the Power and Thermal Data-sheet.

### 2.10.3.2 Software P-state Limit Control

D18F3x68 [Software P-state Limit] provides a software mechanism to limit the P-state MSRC001\_0061[CurP-stateLimit]. See 2.5.3 [CPU Power Management].

### 2.10.3.3 THERMTRIP

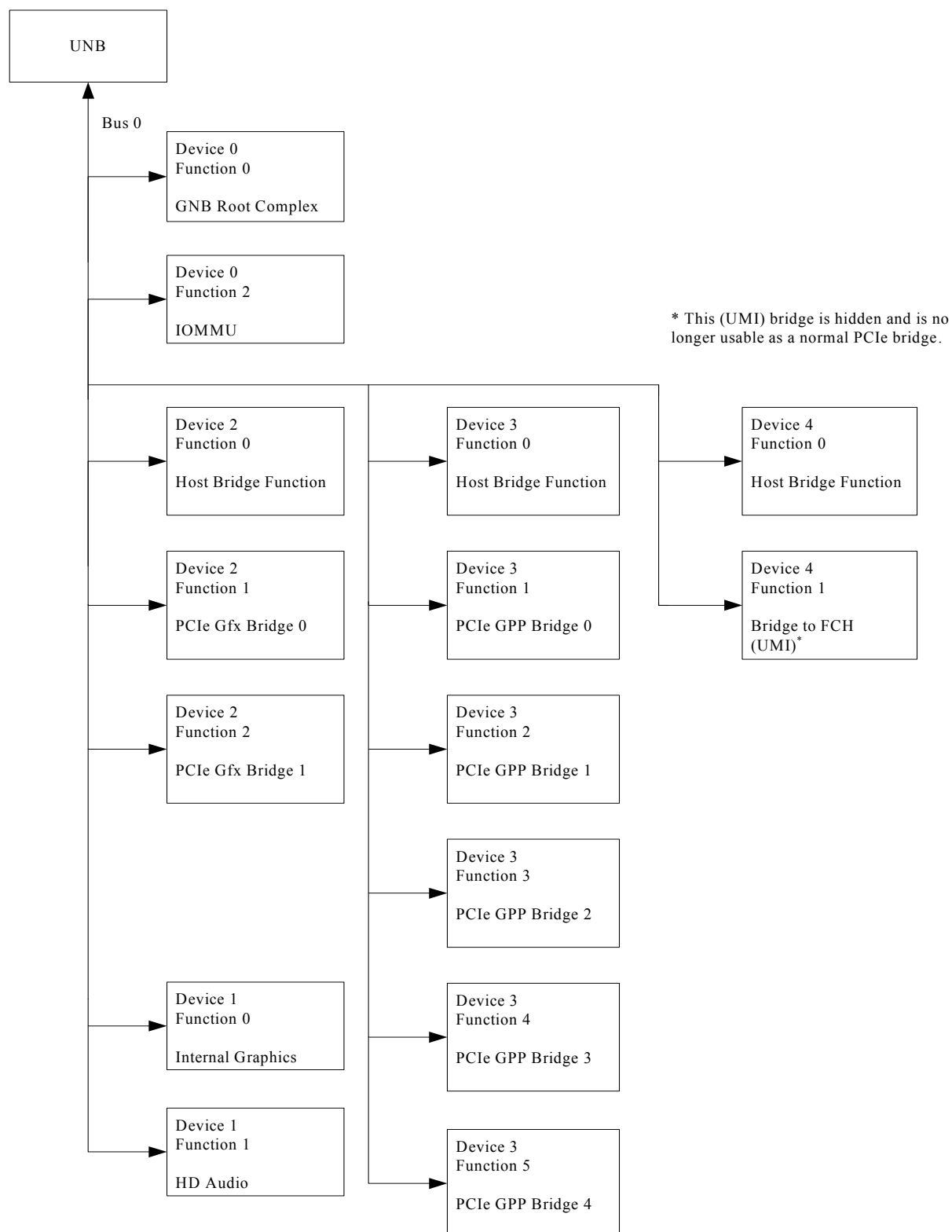
If the processor supports the THERMTRIP state (as specified by D18F3xE4[ThermtEn] or CPUID Fn8000\_0007\_EDX[TTP], which are the same) and the temperature approaches the point at which the processor may be damaged, the processor enters the THERMTRIP state. The THERMTRIP function is enabled after cold reset (after PWROK asserts and RESET\_L deasserts). It remains enabled in all other processor states, except during warm reset (while RESET\_L is asserted). The THERMTRIP state is characterized as follows:

- The THERMTRIP\_L signal is asserted.
- Nearly all clocks are gated off to reduce dynamic power.
- A low-value VID is generated.
- The system is placed into the S5 ACPI state (power off).

A cold reset is required to exit the THERMTRIP state.

## 2.11 Root Complex

### 2.11.1 Overview



**Figure 8: Root complex topology**

## 2.11.2 Interrupt Routing

The GNB includes a fully programmable IOAPIC. The IOAPIC registers are accessed through the [D0F0xF8](#) index and [D0F0xFC](#) data pair registers using two back-to-back config cycles. PCI defined INTx interrupts for each bridge are routed to IOAPIC pins via the bridge interrupt routing registers located at [D0F0xFC\\_x1\[B:0\]](#).

### 2.11.2.1 IOAPIC Configuration

The IOAPIC configuration is performed by the following sequence:

1. Set the base address for the memory mapped registers by programming [D0F0xFC\\_x01](#)[IoapicAddr] and [D0F0xFC\\_x02](#)[IoapicAddrUpper].
2. Enable IOAPIC by programming [D0F0xFC\\_x00](#)[IoapicEnable] = 1.
3. Only if the system is in PIC mode, program [D0F0xFC\\_x00](#)[IoapicSbFeatureEn] = 1. This bit should be programmed to 0 when the system is in APIC mode.

The IOAPIC has a total of 39 interrupt inputs. These inputs are as follows:

- 7 groups of PCIe interrupts each having a 4-bit external interrupt bus (INT A/B/C/D) and a 1-bit bridge interrupt, and
- a 4-bit external interrupt bus from GBIF.

The recommended interrupt routing and swizzling configuration is as shown in [Table 41](#).

**Table 41: Recommended Interrupt Routing and Swizzling Configuration**

| Device  | Register                                   | Setting | Description                                                                        |
|---------|--------------------------------------------|---------|------------------------------------------------------------------------------------|
| Dev2Fn1 | <a href="#">D0F0xFC_x10</a> [BrExtIntrGrp] | 0h      | Map INT A/B/C/D to interrupt 0/1/2/3.<br>Map bridge interrupt to interrupt 16.     |
|         | <a href="#">D0F0xFC_x10</a> [BrExtIntrSwz] | 0h      |                                                                                    |
|         | <a href="#">D0F0xFC_x10</a> [BrIntIntrMap] | 10h     |                                                                                    |
| Dev2Fn2 | <a href="#">D0F0xFC_x11</a> [BrExtIntrGrp] | 1h      | Map INT A/B/C/D to interrupt 4/5/6/7.<br>Map bridge interrupt to interrupt 17.     |
|         | <a href="#">D0F0xFC_x11</a> [BrExtIntrSwz] | 0h      |                                                                                    |
|         | <a href="#">D0F0xFC_x11</a> [BrIntIntrMap] | 11h     |                                                                                    |
| Dev3Fn1 | <a href="#">D0F0xFC_x12</a> [BrExtIntrGrp] | 2h      | Map INT A/B/C/D to interrupt 8/9/10/11.<br>Map bridge interrupt to interrupt 18.   |
|         | <a href="#">D0F0xFC_x12</a> [BrExtIntrSwz] | 0h      |                                                                                    |
|         | <a href="#">D0F0xFC_x12</a> [BrIntIntrMap] | 12h     |                                                                                    |
| Dev3Fn2 | <a href="#">D0F0xFC_x13</a> [BrExtIntrGrp] | 3h      | Map INT A/B/C/D to interrupt 12/13/14/15.<br>Map bridge interrupt to interrupt 19. |
|         | <a href="#">D0F0xFC_x13</a> [BrExtIntrSwz] | 0h      |                                                                                    |
|         | <a href="#">D0F0xFC_x13</a> [BrIntIntrMap] | 13h     |                                                                                    |

**Table 41: Recommended Interrupt Routing and Swizzling Configuration**

| Device  | Register                    | Setting | Description                                                                        |
|---------|-----------------------------|---------|------------------------------------------------------------------------------------|
| Dev3Fn3 | D0F0xFC_x14[BrExtIntrGrp]   | 4h      | Map INT A/B/C/D to interrupt 16/17/18/19.<br>Map bridge interrupt to interrupt 20. |
|         | D0F0xFC_x14[BrExtIntrSwz]   | 0h      |                                                                                    |
|         | D0F0xFC_x14[BrIntIntrMap]   | 14h     |                                                                                    |
| Dev3Fn4 | D0F0xFC_x15[BrExtIntrGrp]   | 5h      | Map INT A/B/C/D to interrupt 20/21/22/23.<br>Map bridge interrupt to interrupt 21. |
|         | D0F0xFC_x15[BrExtIntrSwz]   | 0h      |                                                                                    |
|         | D0F0xFC_x15[BrIntIntrMap]   | 15h     |                                                                                    |
| Dev3Fn5 | D0F0xFC_x16[BrExtIntrGrp]   | 6h      | Map INT A/B/C/D to interrupt 24/25/26/27.<br>Map bridge interrupt to interrupt 18. |
|         | D0F0xFC_x16[BrExtIntrSwz]   | 0h      |                                                                                    |
|         | D0F0xFC_x16[BrIntIntrMap]   | 12h     |                                                                                    |
| GBIF    | D0F0xFC_x0F[GBIFExtIntrGrp] | 0h      | Map INT A/B/C/D to interrupt 2/3/0/1.                                              |
|         | D0F0xFC_x0F[GBIFExtIntrSwz] | 2h      |                                                                                    |

### 2.11.3 Links

#### 2.11.3.1 Overview

There are 3 PCIe cores: one 2 x16 core and two 5 x8 cores. There are 8 configurable ports, which can be divided into 2 groups:

- Gfx: Contains 2 x8 ports. Each port can be limited to lower link widths for applications that require fewer lanes. Additionally, the two ports can be combined to create a single x16 link.
- GPP: Contains 1 x4 UMI and 5 General Purpose Ports (GPP).

All PCIe links are capable of supporting Gen1/Gen2 data rates. In addition, the Gfx link is capable of supporting Gen3 data rate.

The FP3 package supports two different voltage levels on the VDDP rail. At the 1.05V nominal setting, the Gfx link can support Gen3 data rate, while at the 0.95V setting, the maximum data rate supported by the Gfx link is Gen2. See 2.9.2 for its effect on DDR3 data rate.

Gfx and GPP ports each have a Type 1 Virtual PCI-to-PCI bridge header in the PCI configuration space mapped to devices according to Figure 8.

Each PCIe and DDI lane is assigned a unique lane ID that software uses to communicate configuration information to the SMU.

#### 2.11.3.2 Link Configurations

Lanes of the Gfx ports can be assigned to IO links or DDI links.  
The following link configurations are supported for the Gfx links:

**Table 42: Supported Gfx Port Configurations**

| Gfx Port Lanes |     |         |       |
|----------------|-----|---------|-------|
| 3:0            | 7:4 | 11:8    | 15:12 |
| x16 Link       |     |         |       |
| x8 Link        |     | x8 Link |       |



**Table 42: Supported Gfx Port Configurations**

| Gfx Port Lanes |         |          |         |
|----------------|---------|----------|---------|
| 3:0            | 7:4     | 11:8     | 15:12   |
| x8 Link        |         | x4 Link  | DDI     |
| x8 Link        |         | DDI      | x4 Link |
| x8 Link        |         | DDI      | DDI     |
| x8 Link        |         | Dual-DVI |         |
| unused         | DDI     | x4 Link  | x4 Link |
| x4 Link        | x4 Link | DDI      | DDI     |
| x4 Link        | x4 Link | Dual-DVI |         |
| x4 Link        | DDI     | x4 Link  | DDI     |
| x4 Link        | DDI     | DDI      | x4 Link |
| x4 Link        | DDI     | DDI      | DDI     |
| x4 Link        | DDI     | Dual-DVI |         |
| x4 Link        | DDI     | x8 Link  |         |
| Dual-DVI       |         | x8 Link  |         |
| Dual-DVI       |         | x4 Link  | x4 Link |
| Dual-DVI       |         | DDI      | x4 Link |
| Dual-DVI       |         | x4 Link  | DDI     |
| Dual-DVI       |         | DDI      | DDI     |
| Dual-DVI       |         | Dual-DVI |         |

To achieve the above configurations, program the following registers:

- Program Gfx function in [D0F0xE4\\_x013\[2:0\]\\_0080](#)[StrapBifLinkConfig].
- Program Gfx PIF 0 and Gfx PIF 1 in the following registers [D0F0xE4\\_x0\[210,11\[3:0\]\]\\_0011](#).
- Program Gfx TX Lane Mux in the following registers [D0F0xE4\\_x013\[3:0\]\\_802\[4:1\]](#).
- Program Gfx RX Lane Mux in the following registers [D0F0xE4\\_x013\[3:0\]\\_802\[8:5\]](#).
- Program OwnSlice in the Gfx registers in [D0F0xE4\\_x013\[3:0\]\\_804\[3:0\]](#)[OwnSlice].

The following DP0/DP1 DDI configurations are supported:

**Table 43: Supported DP0/DP1 DDI Link Configurations**

| Lanes[3:0]          | Lanes[7:4] |
|---------------------|------------|
| DDI                 | DDI        |
| DDI (Dual-link DVI) |            |

The following link configurations are supported for the GPP links:

**Table 44: Supported General Purpose (GPP) Link Configurations**

| D0F0xE4    |            | GPP Port Lane |   |         |         |         |   |   |   |
|------------|------------|---------------|---|---------|---------|---------|---|---|---|
| x0130_0080 | x0111_0011 | 0             | 1 | 2       | 3       | 4       | 5 | 6 | 7 |
| 0000_0001h | 0000_0300h | x4 Link       |   |         |         | x4 Link |   |   |   |
| 0000_0002h | 0000_0203h | x2 Link       |   | x2 Link |         | x4 Link |   |   |   |
| 0000_0003h | 0000_0201h | x2 Link       |   | x1 Link | x1 Link | x4 Link |   |   |   |

**Table 44: Supported General Purpose (GPP) Link Configurations**

| D0F0xE4    |            | GPP Port Lane |         |         |         |         |   |   |   |
|------------|------------|---------------|---------|---------|---------|---------|---|---|---|
| x0130_0080 | x0111_0011 | 0             | 1       | 2       | 3       | 4       | 5 | 6 | 7 |
| 0000_0003h | 0000_0202h | x1 Link       | x1 Link | x2 Link |         | x4 Link |   |   |   |
| 0000_0004h | 0000_0200h | x1 Link       | x1 Link | x1 Link | x1 Link | x4 Link |   |   |   |
| 0000_0001h | 0000_0300h | x4 Link       |         |         |         | DDI     |   |   |   |
| 0000_0002h | 0000_0203h | x2 Link       |         | x2 Link |         | DDI     |   |   |   |
| 0000_0003h | 0000_0201h | x2 Link       |         | x1 Link | x1 Link | DDI     |   |   |   |
| 0000_0003h | 0000_0202h | x1 Link       | x1 Link | x2 Link |         | DDI     |   |   |   |
| 0000_0004h | 0000_0200h | x1 Link       | x1 Link | x1 Link | x1 Link | DDI     |   |   |   |

## 2.11.4 Root Complex Configuration

### 2.11.4.1 LPC MMIO Requirements

To ensure proper operation of LPC generated DMA requests, the UMI must be configured to send processor generated MMIO writes that target the LPC bus to the FCH as non-posted writes. To ensure this requirement the MMIO address space of the LPC bus must not be included in the ranges specified by [D18F1x\[2CC:2A0,1CC:180,BC:80\] \[MMIO Base/Limit\]](#) and non-posted protocol for memory writes must be enabled using the following sequence before LPC DMA transactions are initiated.

1. Configure the FCH to use the non-posted write protocol. See the FCH register specification for configuration details.
2. Locate the PCIe core that has the UMI link (read [D0F0x64\\_x1F](#) to get location of the FCH).
3. Note that this step should only be performed for the PCIe core with the UMI link (found via step 2 above). Program [D0F0xE4\\_x014\[2:0\]\\_0010\[UmNpMemWrite\]](#) = 1.
4. Program [D0F0x98\\_x06\[UmNpMemWrEn\]](#) = 1.

### 2.11.4.2 Configuration for non-FCH Bridges

BIOS should program the following in non-FCH bridges:

1. Program [D0F0xCC\\_x01\\_ib\[21,1D:19,12:11\]\[CrSEnable\]](#) = 1 for [D0F0xC8\[NbDevIndSel\]](#) = 11h-12h, 19h-1Dh.
2. Program [D0F0xCC\\_x01\\_ib\[21,1D:19,12:11\]\[SetPowEn\]](#) = 1 for [D0F0xC8\[NbDevIndSel\]](#) = 11h-12h, 19h-1Dh.

### 2.11.4.3 Link Configuration and Initialization

Link configuration and initialization is performed by the following sequence:

1. [2.11.4.3.1 \[Link Configuration and Core Initialization\]](#)
2. [2.11.4.3.2 \[Link Training\]](#)
3. [2.11.4.5 \[Link Power Management\]](#)
4. Lock link configuration registers.
  - Program [D0F0xE4\\_x014\[2:0\]\\_0010\[HwInitWrLock\]](#) = 1.
  - Program [D0F0x64\\_x00\[HwInitWrLock\]](#) = 1.
5. IF (external FCH connected through UMI using [D0F0xC8\[NbDevIndSel\]](#)) THEN program [D0F0xCC\\_x01\\_ib\[21,1D:19,12:11\]\[CfgDis\]](#) = 1.

### 2.11.4.3.1 Link Configuration and Core Initialization

Link configuration is done on a per link basis. Lane reversal, IO link/DDI link selection, and lane enablement is configured through this sequence.

1. Place software-reset module into blocking mode:
  - A. Program D0F0xE4\_x013[3:0]\_8062[ConfigXferMode]=0.
  - B. Program D0F0xE4\_x013[3:0]\_8062[BlockOnIdle]=0.
2. If the link is an IO link, Program D0F0xE4\_x014[2:0]\_0011[DynClkLatency]=Fh.
3. Program D0F0xE4\_x013[2:0]\_0080 per Table 44.
4. Program D0F0xE4\_x013[3:0]\_802[4:1] per Table 44.
5. Program D0F0xE4\_x0[210,11[3:0]]\_0010[RxDetectTxPwrMode]=1.
6. Program D0F0xE4\_x0[210,11[3:0]]\_0010[Ln2ExitTime]=000b.
7. Program D0F0xE4\_x013[3:0]\_8013[MasterPciePllA, MasterPciePllB, MasterPciePllC, MasterPciePllD] per Table 44.
8. Initiate core reconfiguration sequence:
  - A. Program D0F0xE4\_x013[3:0]\_8062[ReconfigureEn]=1.
  - B. Program D0F0xE4\_x013[3:0]\_8060[Reconfigure]=1.
  - C. Wait for D0F0xE4\_x013[3:0]\_8060[Reconfigure]==0.
  - D. Program D0F0xE4\_x013[3:0]\_8062[ReconfigureEn]=0.
9. Return software-reset module to non-blocking mode:
  - A. Program D0F0xE4\_x013[3:0]\_8062[ConfigXferMode]=1.
10. Program D[4:2]F[5:1]xE4\_xC1[StrapReverseLanes] if necessary.
11. Program D0F0xE4\_x0[210,11[3:0]]\_0011 per Table 44.
12. Program D0F0xE4\_x0[220,123:120]\_F[E][7:0][8,0]6 per Table 91.
13. For each link mapped to DDI:
  - A. Program D0F0xE4\_x0[210,11[3:0]]\_001[8:7,3:2][PllPowerStateInTxs2]=111b.
  - B. Program D0F0xE4\_x0[210,11[3:0]]\_001[8:7,3:2][PllPowerStateInOff]=111b.
  - C. Program D0F0xE4\_x0[210,11[3:0]]\_001[8:7,3:2][PllRampUpTime]=010b.
14. For each nibble that has no PCIe lanes in use:
  - A. Program D0F0xE4\_x0[210,11[3:0]]\_001[8:7,3:2][PllPowerStateInOff]=111b.
  - B. Program D0F0xE4\_x0[210,11[3:0]]\_001[8:7,3:2][PllPowerStateInTxs2]=111b.
  - C. Program D0F0xE4\_x0[210,11[3:0]]\_001[8:7,3:2][TxPowerStateInTxs2]=111b.
  - D. Program D0F0xE4\_x0[210,11[3:0]]\_001[8:7,3:2][RxPowerStateInRxs2]=111b.
15. For each lane that is not in use, program the corresponding D0F0xE4\_x013[3:0]\_8029[LaneEnable]=0.
16. If the link is a DDI link:
  - A. Program D0F0xE4\_x013[3:0]\_804[3:0][OwnSlice] per Table 42.
17. Configure PIF parings and disable ganged mode for UMI:
  - A. Program D0F0xE4\_x0110\_0011=0000\_0300h.
  - B. Program D0F0xE4\_x0120\_6[3:2][8,0]5[GangedModeEn]=0.

### 2.11.4.3.2 Link Training

Link training is performed on a per link basis. BIOS may train the links in parallel.

### 2.11.4.4 Miscellaneous Features

#### 2.11.4.4.1 Lane Reversal

Normally, the lanes of each port are physically numbered from n-1 to 0 where n is the number of lanes assigned to the port. Physical lane numbering can be reversed according to the following methods:

- To reverse the physical lane numbering for a specific port, program D[4:2]F[5:1]xE4\_xC1[StrapReverseLanes]=1.

- To reverse the physical lane numbering for all ports in the GPP or GFX interfaces, program `D0F0xE4_x014[2:0]_00C0[StrapReverseAll]=1`.

Note that logical port numbering is established during link training regardless of the physical lane numbering.

#### 2.11.4.4.2 Link Speed Changes

Link speed changes can only occur on Gen2 and Gen2/Gen3 capable links. To verify that Gen2/Gen3 speeds are supported verify `D[4:2]F[5:1]x64[LinkSpeed]==02h` or `D[4:2]F[5:1]x64[LinkSpeed]==03h`. Note that Gen3 support is only for the graphics link.

##### 2.11.4.4.2.1 Autonomous Link Speed Changes

To enable autonomous speed changes on a per port basis:

1. Program `D[4:2]F[5:1]x88[TargetLinkSpeed]=2h`.
2. Program `D0F0xE4_x013[2:0]_0[C:8]03[StrapBifDeemphasisSel]=1`.
3. Program `D[4:2]F[5:1]xE4_xA4[LcGen2EnStrap]=1`.
4. Program `D[4:2]F[5:1]xE4_xC0[StrapAutoRcSpeedNegotiationDis]=0`.
5. Program `D[4:2]F[5:1]xE4_xA4[LcMultUpstreamAutoSpdChngEn]=1`.
6. Program `D[4:2]F[5:1]xE4_xA2[LcUpconfigureDis]=0`.

To enable autonomous speed changes on a per port basis for Gen3:

1. Program `D[4:2]F[5:1]x88[TargetLinkSpeed]=3h`.
2. Program `D[4:2]F[5:1]xE4_xA4[LcGen3EnStrap]=1`.
3. Program `D[4:2]F[5:1]xE4_xC0[StrapAutoRcSpeedNegotiationDis]=0`.

##### 2.11.4.4.3 Deemphasis

Deemphasis strength can be changed on a per-port basis by programming `D[4:2]F[5:1]xE4_xB5[LcSelectDeemphasis]`.

#### 2.11.4.5 Link Power Management

##### 2.11.4.5.1 Link States

To enable support for L1 program `D[4:2]F[5:1]xE4_xA0[LcL1Inactivity]=6h`.

To enable support for L0s:

- Program `D[4:2]F[5:1]xE4_xA1[LcDontGotoL0sifL1Armed]=1`.
- Program `D[4:2]F[5:1]xE4_xA0[LcL0sInactivity]=9h`.

##### 2.11.4.5.2 Dynamic Link-width Control

Dynamic link-width control is a power saving feature that reconfigures the link to run with fewer lanes. The inactive lanes are turned off to conserve power.

Each link can switch among widths of: x1, x2, x4, x8, and x16, up to the maximum port width.

The link width is controlled by the following mechanism:

- Up/Down Reconfiguration: The link is retrained according to the PCI Express specification.

The core has the capability to turn off the inactive lanes of trained links. To enable this feature program [D\[4:2\]F\[5:1\]xE4\\_xA2\[LcDynLanesPwrState\]=11b](#).

#### 2.11.4.6 Link Test and Debug Features

##### 2.11.4.6.1 Compliance Mode

To enable Gen1 software compliance mode program [D\[4:2\]F\[5:1\]xE4\\_xC0\[StrapForceCompliance\]=1](#) for each port to be placed in compliance mode.

To enable Gen2 software compliance mode:

1. BIOS enables Gen2 capability by programming [D0F0xE4\\_x014\[2:0\]\\_00C1\[StrapGen2Compliance\]=1](#).
2. Program [D\[4:2\]F\[5:1\]xE4\\_xA4\[LcGen2EnStrap\]=1](#).
3. Program [D\[4:2\]F\[5:1\]x88\[TargetLinkSpeed\]=2h](#) for each port to be placed in compliance mode.
4. Program [D\[4:2\]F\[5:1\]x88\[EnterCompliance\]=1](#) for each port to be placed in compliance mode.

To enable Gen3 software compliance mode:

1. BIOS enables Gen3 capability on the Gfx link by programming [D0F0xE4\\_x0140\\_00C1\[StrapGen3Compliance\]=1](#).
2. Program [D\[4:2\]F\[5:1\]xE4\\_xA4\[LcGen3EnStrap\]=1](#).
3. Program [D\[4:2\]F\[5:1\]x88\[TargetLinkSpeed\]=3h](#) for each port to be placed in compliance mode.
4. Program [D\[4:2\]F\[5:1\]x88\[EnterCompliance\]=1](#) for each port to be placed in compliance mode.

#### 2.11.5 FCH Messages

To replace the wires and messages previously used between the processor and the FCH, upstream and downstream messages are defined through a combination of messages and reads or posted writes of special addresses. These message packets look like regular PCIe packets, but are AMD proprietary packets across the UMI link.

#### 2.11.6 BIOS Timer

The root complex implements a 32-bit microsecond timer (see [D0F0xE4\\_x0132\\_80F0](#) and [D0F0xE4\\_x0132\\_80F1](#)) that the BIOS can use to accurately time wait operations between initialization steps.

To ensure that BIOS waits a minimum number of microseconds between steps BIOS should always wait for one microsecond more than the required minimum wait time.

#### 2.11.7 PCIe Client Interface Control

This interface is accessed through the indexed space registers located at [D0F2xF8](#) within the [Device 0 Function 2 \(IOMMU\) Configuration Registers](#).

BIOS should perform the following steps to initialize the interface:

1. Program [D0F0x64\\_x0D\[PciDev0Fn2RegEn\] = 1h](#).
2. Program credits for the BIF client as follows:
  - A. Program [D0F2xFC\\_x32\\_L1i\[3\]\[DmaNpHaltDis\] = 1h](#).
  - B. Program [D0F2xFC\\_x32\\_L1i\[3\]\[DmaBufCredits\] = 20h](#).
  - C. Program [D0F2xFC\\_x32\\_L1i\[3\]\[DmaBufMaxNpCred\] = 20h](#).
3. Program credits for the PGD client as follows:
  - A. Program [D0F2xFC\\_x32\\_L1i\[0\]\[DmaBufCredits\] = 20h](#).

- B. Program D0F2xFC\_x32\_L1i[0][DmaBufMaxNpCred] = 1Fh.
- 4. Program credits for the INTGEN client as follows:
  - A. Program D0F2xFC\_x32\_L1i[4][DmaNpHaltDis] = 1h.
  - B. Program D0F2xFC\_x32\_L1i[4][DmaBufCredits] = 4h.
  - C. Program D0F2xFC\_x32\_L1i[4][DmaBufMaxNpCred] = 4h.
- 5. Program clock gating as follows:
  - A. Program D0F2xFC\_x33\_L1i[4:0][L1DmaClkgateEn] = 1h.
  - B. Program D0F2xFC\_x33\_L1i[4:0][L1CacheClkgateEn] = 1h.
  - C. Program D0F2xFC\_x33\_L1i[4:0][L1CpslvClkgateEn] = 1h.
  - D. Program D0F2xFC\_x33\_L1i[4:0][L1DmaInputClkgateEn] = 1h.
  - E. Program D0F2xFC\_x33\_L1i[4:0][L1PerfClkgateEn] = 1h.
  - F. Program D0F2xFC\_x33\_L1i[4:0][L1MemoryClkgateEn] = 1h.
  - G. Program D0F2xFC\_x33\_L1i[4:0][L1RegClkgateEn] = 1h.
  - H. Program D0F2xFC\_x33\_L1i[4:0][L1HostreqClkgateEn] = 1h.
  - I. Program D0F2xFC\_x33\_L1i[4:0][L1L2ClkgateEn] = 1h.
  - J. Program D0F2xF4\_x33[CKGateL2ARegsDisable] = 0h.
  - K. Program D0F2xF4\_x33[CKGateL2ADynamicDisable] = 0h.
  - L. Program D0F2xF4\_x33[CKGateL2ACacheDisable] = 0h.
  - M. Program D0F2xF4\_x90[CKGateL2BRegsDisable] = 0h.
  - N. Program D0F2xF4\_x90[CKGateL2BDynamicDisable] = 0h.
  - O. Program D0F2xF4\_x90[CKGateL2BMiscDisable] = 0h.
- 6. Program D0F0x64\_x0D[PciDev0Fn2RegEn] = 0h.

## 2.12 IOMMU

The processor includes an IOMMU revision 2. See the *AMD I/O Virtualization Technology (IOMMU) Specification*.

### 2.12.1 IOMMU Configuration Space

The IOMMU configuration space consists of the following four groups:

- PCI Configuration space. See 3.4 [Device 0 Function 2 (IOMMU) Configuration Registers].
- IOMMU Memory Mapped Register space. See 3.16 [IOMMU Memory Mapped Registers].
- IOMMU L1 Indexed space accessed through D0F2xF8 [IOMMU L1 Config Index].
- IOMMU L2 Indexed space accessed through D0F2xF0 [IOMMU L2 Config Index].

### 2.12.2 IOMMU Initialization

BIOS should perform the following steps to initialize the IOMMU:

1. Program D0F0x64\_x0D[PciDev0Fn2RegEn] = 1h.
2. Program D0F2x44 [IOMMU Base Address Low] and D0F2x48 [IOMMU Base Address High] to allocate a 512K region of MMIO space for IOMMU memory mapped registers. This region of MMIO space is reserved for IOMMU and BIOS must not allocate it for use by system software.
3. Program D0F2x50[IommuHtAtsResv] = 0h.
4. Program D0F2x44[IommuEnable]=1.
5. Program D0F2x70[PrefSupW]=0.
6. Program D[4:2]F[5:1]xE4\_xC1[StrapExtendedFmtSupported]=1 and D[4:2]F[5:1]xE4\_xC1[StrapE2EPrefixEn]=1.
7. Program IOMMUx18[Isoc]=1h if processors support isochronous channel.
8. Program the registers with BIOS recommendations in L1 (D0F2xFC) and L2 (D0F2xF4) indexed space. See 2.11.7 [PCIe Client Interface Control].
9. Check if any PCIe devices in the system support the Phantom Function. For each PCIe core that has a connected device advertising support for the Phantom Function, program D0F2xFC\_x07\_L1i[4:0][0]=0 for the L1 corresponding to that PCIe core.
10. If a PCIe port is hot-plug capable, then program D0F2xFC\_x07\_L1i[4:0][0]=0 for the L1 corresponding to the PCIe core.
11. If at least one PCIE to PCI-x bridge exists on a PCIe port or a HotPlug capable PCIe slot is present on a PCIe port then program D0F2xFC\_x0D\_L1i[4:0][VOQPortBits]=111b for the L1 corresponding to the particular PCIE core.
12. Program the location of the SB into D0F2xF4\_x49 [L2\_SB\_LOCATION]. The program value is required to match the value programmed in D0F0x64\_x1F [FCH Location].
13. Program the port location of the SB into D0F2xFC\_x09\_L1i[4:0] [L1\_SB\_LOCATION] for the L1 corresponding to the iFCH or the PCIE core which FCH is located. Leave register at default value for all L1s corresponding to other PCIE cores.

#### 2.12.2.1 IOMMU L1 Initialization

BIOS should perform the following steps to initialize the IOMMU L1:

1. Program D0F2xFC\_x0C\_L1i[4:0][L1VirtOrderQueues]=4h.
2. Program D0F2xFC\_x32\_L1i[4:0][AtsMultipleRespEn]=1h.
3. Program D0F2xFC\_x32\_L1i[4:0][AtsMultipleL1toL2En]=1h.
4. Program D0F2xFC\_x32\_L1i[4:0][TimeoutPulseExtEn]=1h.



5. Program `D0F2xFC_x07_L1i[4:0][AtsPhysPageOverlapDis]=1h`.
6. Program `D0F2xFC_x07_L1i[4:0][AtsSeqNumEn]=1h`.
7. Program `D0F2xFC_x07_L1i[4:0][SpecReqFilterEn]=1h`.
8. Program `D0F2xFC_x07_L1i[4:0][L1NwEn]=1h`.

### 2.12.2.2 IOMMU L2 Initialization

BIOS should perform the following steps to initialize the IOMMU L2:

1. Program `D0F2xF4_x10[DTCInvalidationSel]=2h`.
2. Program `D0F2xF4_x14[ITCInvalidationSel]=2h`.
3. Program `D0F2xF4_x18[PTCAInvalidationSel]=2h`.
4. Program `D0F2xF4_x50[PDCInvalidationSel]=2h`.
5. Program `D0F2xF4_x80[ERRRuleLock0]=1h`.
6. Program `D0F2xF4_x30[ERRRuleLock1]=1h`.
7. Program `D0F2xF4_x34[L2aregHostPgsize]=2h`.
8. Program `D0F2xF4_x34[L2aregGstPgsize]=2h`.
9. Program `D0F2xF4_x94[L2bregHostPgsize]=2h`.
10. Program `D0F2xF4_x94[L2bregGstPgsize]=2h`.
11. Program `D0F2xF4_x4C[GstPartialPtcCntrl]=3h`.
12. If no internal gfx, program `D0F2xF4_x57[L1ImuIntGfxDis]=1h`.
13. If no external gfx, program `D0F2xF4_x57[0]=1h`.
14. Program `D0F2xF4_x47[TwAtomicFilterEn]=1h`.
15. Program `D0F2xF4_x47[TwNwEn]=1h`.
16. Program `D0F2xF4_x56[CPFlushOnWait]=1h`.
17. Program `D0F2xF4_x56[CPFlushOnInv]=0h`.
18. Program `D0F2xF4_x53[L2bUpdateFilterBypass]=0h`.
19. Program `D0F2xF4_x22[L2aUpdateFilterBypass]=0h`.

### 2.12.2.3 IOMMU SMI Filtering

In order to ensure system management interrupts come from valid peripheral sources, the IOMMU supports an SMI filter (`IOMMUx30[SmiFSup]==01b`). SMI interrupts are filtered according to the values programmed in the SMI filter registers. The registers specify what sources are allowed to send SMI interrupts. `IOMMUx30[SmiFRC]` indicates the number of SMI filter registers available.

The BIOS should set up the SMI filter registers and lock them. These setting will take effect when system software enables the IOMMU and enables SMI filtering. BIOS should perform the following steps to set up SMI filtering:

1. Program `D0F2x70[SmifSupW]=1h`.
2. Choose an SMI filter register from the available set described in `IOMMUx30[SmiFRC]`. Select one register for each SMI source.
3. Program selected SMI filter register to the Device ID of the peripheral issuing the SMI interrupts via `IOMMUx[78,70,68,60][SMIDid]`. Program one register for each SMI source.
4. Program selected SMI filter register to be valid via `IOMMUx[78,70,68,60][SMIDV]`. Program one register for each SMI source.
5. Program selected SMI filter register to be locked via `IOMMUx[78,70,68,60][SMIFlock]`. Program one register for each SMI source.



## 2.13 System Management Unit (SMU)

The system management unit (SMU) is a subcomponent of the northbridge that is responsible for a variety of system and power management tasks during boot and runtime. The SMU contains a microcontroller to assist with many of these tasks.

### 2.13.1 Software Interrupts

The microcontroller can be interrupted to cause it to perform several initialization and runtime tasks. BIOS and ACPI methods can interrupt the SMU to request a specific action using the following sequence:

1. If a service request requires an argument, program `D0F0xBC_xC210_003C`[Argument] with the desired argument.
1. Wait for `D0F0xBC_xC210_0004`[IntDone]==1.
2. Program `D0F0xBC_xC210_0000`[ServiceIndex] to the desired service index and toggle. This may be done in a single write.
3. Wait for `D0F0xBC_xC210_0004`[IntAck]==1.

After performing the steps above, software may continue execution before the interrupt has been serviced. However, software should not rely on the results of the interrupt until the service is complete (see `D0F0xBC_xC210_0004`[IntDone]). Interrupting the SMU with a service index that does not exist results in undefined behavior.

**Table 45: SMU Software Interrupts**

| Service Index | Notes                                                                                                                                                                                                                                                                                                                      |
|---------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1Eh           | Description: <b>BIOSMC_MSG_LCLK_DPM_ENABLE</b> . Enables LCLK DPM. See 2.5.6.1.3 [LCLK DPM].                                                                                                                                                                                                                               |
|               | Input: <code>D0F0xBC_x3FDC8</code>                                                                                                                                                                                                                                                                                         |
|               | Output: None.                                                                                                                                                                                                                                                                                                              |
| 3Ah           | Description: <b>BIOSMC_MSG_VDDNB_REQUEST</b> . Request VDDNB voltage.                                                                                                                                                                                                                                                      |
|               | Input: Program argument to desired voltage (encoded in mV with two fraction bits). Values outside <code>D18F5x17C</code> [MaxVid, MinVid] range are invalid and result in undefined behavior. <ul style="list-style-type: none"> <li>• <code>D0F0xBC_xC210_003C</code>[Argument] = (Desired Voltage in mV) * 4.</li> </ul> |
|               | Output: None.                                                                                                                                                                                                                                                                                                              |
| 43h           | Description: <b>BIOSMC_MSG_NBDPM_Enable</b> . Enables NB P-state Adjustments. See 2.5.4.1.1 [Northbridge Dynamic Power Management (NB DPM)].                                                                                                                                                                               |
|               | Input: <code>D0F0xBC_x3F9E8</code>                                                                                                                                                                                                                                                                                         |
|               | Output: <code>D0F0xBC_x3F9EC</code>                                                                                                                                                                                                                                                                                        |

## 2.14 Graphics Processor (GPU)

The APU contains an integrated DX11 compliant graphics processor.

### 2.14.1 Graphics Memory Controller (GMC)

The graphics memory controller is responsible for servicing memory requests from the different blocks within

the GPU and forwarding routing them to the appropriate interface. The GMC is also responsible for translating GPU virtual address to GPU physical addresses and for translating GPU physical addresses to system addresses.

### 2.14.2 Frame Buffer (FB)

The frame buffer is defined as the portion of system memory dedicated for GPU use.

**Table 46: Recommended Frame Buffer Configurations**

| System Memory Size                | Frame Buffer Size |
|-----------------------------------|-------------------|
| < 2 GB                            | 256 MB            |
| >= 2 GB & < 4 GB                  | <u>256 MB</u>     |
| <u>&gt;= 4 GB &amp; &lt; 4 GB</u> | 512 MB            |
| >= 6 GB                           | 1 GB              |

## 2.15 RAS Features

### 2.15.1 Machine Check Architecture

The processor contains logic and registers to detect, log, and correct errors in the data or control paths in each core and the Northbridge. The Machine Check Architecture (MCA) defines the facilities by which processor and system hardware errors are logged and reported to system software. This allows system software to perform a strategic role in recovery from and diagnosis of hardware errors.

Refer to the AMD64 Architecture Programmer's Manual for an architectural overview and methods for determining the processor's level of MCA support. See 1.2 [Reference Documents].

The ability of hardware to generate a machine check exception upon an error is indicated by [CPUID Fn0000\\_0001\\_EDX\[MCE\]](#) or [CPUID Fn8000\\_0001\\_EDX\[MCE\]](#).

#### 2.15.1.1 Machine Check Registers

[CPUID Fn0000\\_0001\\_EDX\[MCA\]](#) or [CPUID Fn8000\\_0001\\_EDX\[MCA\]](#) indicates the presence of the following machine check registers:

- [MSR0000\\_0179 \[Global Machine Check Capabilities \(MCG\\_CAP\)\]](#)
  - Reports how many machine check register banks are supported.
- [MSR0000\\_017A \[Global Machine Check Status \(MCG\\_STAT\)\]](#)
  - Provides basic information about processor state after the occurrence of a machine check error.
- [MSR0000\\_017B \[Global Machine Check Exception Reporting Control \(MCG\\_CTL\)\]](#)
  - Used by software to enable or disable the logging and reporting of machine check errors in the error-reporting banks.

The error-reporting machine check register banks supported in this processor are:

- MC0: Load-store unit (LS), including data cache.
- MC1: Instruction fetch unit (IF), including instruction cache.
- MC2: Combined unit (CU), including L2 cache.
- MC3: Reserved.
- MC4: Northbridge (NB), including the IO link. There is only one NB error reporting bank, independent of the number of cores.
- MC5: execution unit (EX), including mapper/scheduler/retire/execute functions and fixed-issue reorder buffer.
- MC6: Floating point unit (FP).
- The register types within each bank are:
  - [MCi\\_CTL](#), Machine Check Control: Enables error reporting via machine check exception. The [MCi\\_CTL](#) register in each bank must be enabled by the corresponding enable bit in [MCG\\_CTL \(MSR0000\\_017B\)](#).
  - [MCi\\_STATUS](#), Machine Check Status: Logs information associated with errors.
  - [MCi\\_ADDR](#), Machine Check Address: Logs address information associated with errors.
  - [MCi\\_MISC](#), Machine Check Miscellaneous: Log miscellaneous information associated with errors, as defined by each error type.
  - [MCi\\_CTL\\_MASK](#), Machine Check Control Mask: Inhibit detection of an error source unless otherwise specified.

The following table identifies the registers associated with each error-reporting machine check register bank:

**Table 47: MCA register cross-reference table**

| Register Bank (MCi) | MCA Register                 |                              |                              |                              |                              |
|---------------------|------------------------------|------------------------------|------------------------------|------------------------------|------------------------------|
|                     | CTL                          | STATUS                       | ADDR                         | MISC                         | CTL_MASK                     |
| MC0                 | <a href="#">MSR0000_0400</a> | <a href="#">MSR0000_0401</a> | <a href="#">MSR0000_0402</a> | <a href="#">MSR0000_0403</a> | <a href="#">MSRC001_0044</a> |
| MC1                 | <a href="#">MSR0000_0404</a> | <a href="#">MSR0000_0405</a> | <a href="#">MSR0000_0406</a> | <a href="#">MSR0000_0407</a> | <a href="#">MSRC001_0045</a> |
| MC2                 | <a href="#">MSR0000_0408</a> | <a href="#">MSR0000_0409</a> | <a href="#">MSR0000_040A</a> | <a href="#">MSR0000_040B</a> | <a href="#">MSRC001_0046</a> |
| MC3                 | <a href="#">MSR0000_040C</a> | <a href="#">MSR0000_040D</a> | <a href="#">MSR0000_040E</a> | <a href="#">MSR0000_040F</a> | <a href="#">MSRC001_0047</a> |
| MC4                 | <a href="#">MSR0000_0410</a> | <a href="#">MSR0000_0411</a> | <a href="#">MSR0000_0412</a> | <a href="#">MSR0000_0413</a> | <a href="#">MSRC001_0048</a> |
| MC5                 | <a href="#">MSR0000_0414</a> | <a href="#">MSR0000_0415</a> | <a href="#">MSR0000_0416</a> | <a href="#">MSR0000_0417</a> | <a href="#">MSRC001_0049</a> |
| MC6                 | <a href="#">MSR0000_0418</a> | <a href="#">MSR0000_0419</a> | <a href="#">MSR0000_041A</a> | <a href="#">MSR0000_041B</a> | <a href="#">MSRC001_004A</a> |

Corrected, deferred, and uncorrected errors are logged in MCi\_STATUS and MCi\_ADDR as they occur. Uncorrected errors that are enabled in MCi\_CTL result in a Machine Check exception.

Each MCi\_CTL register must be enabled by the corresponding enable bit in [MSR0000\\_017B \[Global Machine Check Exception Reporting Control \(MCG\\_CTL\)\]](#).

MCi\_CTL\_MASK allow BIOS to mask the presence of any error source from software for test and debug. When error sources are masked, it is as if the error was not detected. Such masking consequently prevents error responses and actions.

Each MCA bank implements a number of machine check miscellaneous registers, denoted as MCi\_MISCj, where j goes from 0 to a maximum of 8. If there is more than one MCi\_MISC register in a given bank, a non-zero value in MCi\_MISC0[BlkPtr] points to the contiguous block of additional registers.

The presence of valid information in the first MISC register in the bank (MCi\_MISC0) is indicated by MCi\_STATUS[MiscV]. The presence of valid information in additional implemented MISC registers is indicated by MCi\_MISCj[Val] in the target register.

### 2.15.1.2 Machine Check Errors

The classes of machine check errors are, in priority order from highest to lowest:

- Uncorrected
- Deferred
- Corrected

Uncorrected errors cannot be corrected by hardware and may cause loss of data, corruption of processor state, or both. Uncorrected errors update the status and address registers if not masked from logging in MCi\_CTL\_MASK. Information in the status and address registers from a previously logged lower priority error is overwritten. Previously logged errors of the same priority are not overwritten. Uncorrected errors that are enabled in MCi\_CTL result in reporting to software via machine check exceptions. If an uncorrected error is masked from logging, the error is ignored by hardware (exceptions are noted in the register definitions). If an uncorrected error is disabled from reporting, containment of the error and logging/reporting of subsequent errors may be affected. Therefore, enable reporting of unmasked uncorrected errors for normal operation. Disable reporting of uncorrected errors only for debug purposes.

Deferred errors are errors that cannot be corrected by hardware, but do not cause an immediate interruption in program flow, loss of data integrity, or corruption of processor state. These errors indicate that data has been corrupted but not consumed; no exception is generated because the data has not been referenced by a core or an IO link. Hardware writes information to the status and address registers in the corresponding bank that identifies the source of the error if deferred errors are enabled for logging. If there is information in the status and address registers from a previously logged lower priority error, it is overwritten. Previously logged errors of the same or higher priority are not overwritten. Deferred errors are not reported via machine check exceptions; they can be seen by polling the MCI\_STATUS registers.

Corrected errors are those which have been corrected by hardware and cause no loss of data or corruption of processor state. Hardware writes the status and address registers in the corresponding register bank with information that identifies the source of the error if they are enabled for logging. Corrected errors are not reported via machine check exceptions. Some corrected errors may be reported to software via error thresholding (see [2.15.1.7 \[Error Thresholding\]](#)).

The implications of these categories of errors are:

1. Uncorrected error; hardware did not deal with the problem.
  - Operationally (error handling), action required, because program flow is affected.
  - Diagnostically (fault management), software may collect information to determine if any components should be de-configured or serviced.
2. Deferred error; hardware partially dealt with the problem via containment.
  - Operationally, action optional, because program flow has not been affected. However, steps may be taken by software to prevent access to the data in error.
  - Diagnostically, software may collect information to determine if any components should be de-configured or serviced.
3. Corrected error; hardware dealt with the problem.
  - Operationally, no action required, because program flow is unaffected.
  - Diagnostically, software may collect information to determine if any components should be de-configured or serviced.

Machine check conditions can be simulated to aid in debugging machine check handlers. See [2.15.3 \[Error Injection and Simulation\]](#) for more detail.

### 2.15.1.3 Error Detection, Action, Logging, and Reporting

Error detection is controlled by the MASK registers:

- Error detection for MCA controlled errors is enabled if not masked by MCI\_CTL\_MASK (see [Table 47 \[MCA register cross-reference table\]](#)).
- Error masking is performed regardless of MCA bank enablement in MCG\_CTL ([MSR0000\\_017B](#)).

Error action refers to the hardware response to an error, aside from logging and reporting. Enablement of error action for each error is enumerated in the EAC (Error Action Condition) column of the error descriptions tables as follows:

- D: Detected. The error action is taken if the error is detected (i.e., not masked). These actions occur regardless of whether the MCA bank is enabled in MCG\_CTL.
- E: Enabled. The error action is taken if the error is detected and the bank is enabled in MCG\_CTL.

Error logging refers to the storing of information in the status registers, and is enabled if all of the following are true:

- Error detection is enabled.

- The MCA bank is enabled in MCG\_CTL.

Error reporting refers to active notification of errors to software via machine check exceptions, and is enabled if all of the following are true:

- Error logging is enabled.
- The corresponding enable bit for the error in MCi\_CTL is set to 1.

A machine check exception will be generated if all the following are true:

- The error is uncorrected.
- The error is enabled for reporting.
- CR4.MCE is enabled.

Notes:

1. If CR4.MCE is clear, an error configured to cause a machine check exception will cause a shutdown.
2. If error reporting is disabled, the setting of CR4.MCE has no effect.
3. If an uncorrected error is disabled from reporting, containment of the error and logging/reporting of subsequent errors may be affected. Therefore, unmasked uncorrected errors should be enabled for reporting for normal operation. Uncorrected errors should only be disabled from reporting for debug purposes.
4. Errors not associated with a specific core are reflected to core 0 of the compute unit. The error description tables identify which errors are associated or not associated with a specific core of the compute unit.

Throughout the MCA register descriptions, the terms “enabled” and “disabled” generally refer to reporting, and the terms “masked” and “unmasked” generally refer to logging, unless otherwise noted.

Some logged errors increment a counter in MCi\_MISC, which may trigger an interrupt (see [2.15.1.7 \[Error Thresholding\]](#)). Although no machine check exception will be generated, these notifications can be viewed as “correctable machine check interrupts”.

For debug observability only, [D18F3x180\[ConvertUnCorToCorErrEn\]](#) can be used to log NB uncorrected errors as corrected errors.

### 2.15.1.3.1 MCA conditions that cause Shutdown

The following architectural conditions cause the processor to enter the Shutdown state; see section “Machine-Check Errors” in APM volume 2 for more detail; see [1.2 \[Reference Documents\]](#):

- Attempting to generate an MCE when machine check reporting is disabled at the system level (CR4.MCE=0).
- Attempting to generate an MCE when a machine check is in progress on the same core ([MSR0000\\_017A\[MCIP\]=1](#)).

The following non-architectural conditions cause the processor to enter the Shutdown state:

- EX “Retire dispatch queue parity” error. See [Table 239 \[MC5 Error Descriptions\]](#).
- EX “Mapper checkpoint array parity” error if UC=1. See [Table 239 \[MC5 Error Descriptions\]](#).
- EX “Retire status queue parity” error. See [Table 239 \[MC5 Error Descriptions\]](#)

### 2.15.1.3.2 Error Logging During Overflow

An error to be logged when the status register contains valid data can result in an overflow condition. During error overflow conditions, the new error may not be logged or an error which has already been logged in the status register may be overwritten. For the rules on error overflow, priority, and overwriting, see [MSR0000\\_0401\[Overflow\]](#).

Overflow alone does not indicate a shutdown condition. Uncorrected errors require software intervention. Therefore, when an uncorrected error cannot be logged, critical error information may have been lost, and MCI\_STATUS[PCC] may be set. If PCC is indicated, software should terminate system processing to prevent data corruption (see 2.15.1.6 [Handling Machine Check Exceptions]). If PCC is not indicated, any MCA data lost due to overflow was informational only and not critical to system hardware operation.

The following table indicates which errors are overwritten in the error status registers.

**Table 48: Overwrite Priorities for All Banks**

|             |             |          | Older Error |           |           |           |           |                  |
|-------------|-------------|----------|-------------|-----------|-----------|-----------|-----------|------------------|
|             |             |          | Uncorrected |           | Deferred  |           | Corrected |                  |
|             |             |          | Enabled     | Disabled  | Enabled   | Disabled  | Enabled   | Disabled         |
| Newer Error | Uncorrected | Enabled  | -           | Overwrite | Overwrite | Overwrite | Overwrite | <u>Overwrite</u> |
|             |             | Disabled | -           | -         | Overwrite | Overwrite | Overwrite | Overwrite        |
|             | Deferred    | Enabled  | -           | -         | -         | Overwrite | Overwrite | <u>Overwrite</u> |
|             |             | Disabled | -           | -         | -         | -         | Overwrite | Overwrite        |
|             | Corrected   | Enabled  | -           | -         | -         | -         | -         | <u>Overwrite</u> |
|             |             | Disabled | -           | -         | -         | -         | -         | -                |

#### 2.15.1.4 MCA Initialization

The following initialization sequence must be followed:

- MCI\_CTL\_MASK registers (see Table 47 [MCA register cross-reference table] for list):
  - BIOS must initialize the mask registers to inhibit error detection prior to the initialization of MCI\_CTL and MSR0000\_017B.
  - BIOS must not clear MASK bits that are reset to 1.
- The MCI\_CTL registers must be initialized by the operating system prior to enabling the error reporting banks in MCG\_CTL.

If initializing after a cold reset (see D18F0x6C[ColdRstDet]), then BIOS must clear the MCI\_STATUS MSRs. If initializing after a warm reset, then BIOS should check for valid MCA errors and if present save the status for later diagnostic use (see 2.15.1.6 [Handling Machine Check Exceptions]).

BIOS may initialize the MCA without setting CR4.MCE; this will result in a system shutdown on any machine check which would have caused a machine check exception (followed by a reboot if configured in the chipset). Alternatively, BIOS that wishes to ensure continued operation in the event that a machine check occurs during boot may write MCG\_CTL with all ones and write zeros into each MCI\_CTL. With these settings, a machine check error will result in MCI\_STATUS being written without generating a machine check exception or a system shutdown. BIOS may then poll MCI\_STATUS during critical sections of boot to ensure system integrity. Before passing control to the operating system, BIOS should restore the values of those registers to what the operating system is expecting. (Note that using MCI\_CTL to disable error reporting on uncorrected errors may affect error containment; see 2.15.1.3 [Error Detection, Action, Logging, and Reporting].)

Before ECC memory has been initialized with valid ECC check bits, BIOS must ensure that no memory operations are initiated if MCA reporting is enabled. This includes memory operations that may be initiated by hardware prefetching or other speculative execution. It is recommended that, until all of memory has been initialized with valid ECC check bits, the BIOS either does not have any valid MTRRs specifying a DRAM memory type or does not enable DRAM ECC machine check exceptions.

### 2.15.1.5 Error Code

The MCi\_STATUS[ErrorCode] field contains information used to identify the logged error. [Table 49 \[Error Code Types\]](#) identifies how to decode ErrorCode. The MCi\_STATUS[ErrorCodeExt] field contains detailed, model-specific information that is used to further narrow identification for error diagnosis, but not error handling by software; see [2.15.1.6 \[Handling Machine Check Exceptions\]](#).

For a given error-reporting bank, Error Code Type is used in conjunction with the Extended Error Code (MCi\_STATUS[ErrorCodeExt]) to uniquely identify the Error Type; the value of ErrorCodeExt is unique within Error Code Type. Details for each Error Type are described in the tables accompanying the MCi\_STATUS register for each bank.

- MC0 (LS); [Table 221 \[MC0 Error Signatures\]](#).
- MC1 (IF); [Table 224 \[MC1 Error Signatures\]](#).
- MC2 (CU); [Table 228 \[MC2 Error Signatures\]](#).
- MC4 (NB); [Table 231 \[MC4 Error Signatures, Part 1\]](#) and [Table 232 \[MC4 Error Signatures, Part 2\]](#).
- MC5 (EX); [Table 240 \[MC5 Error Signatures\]](#).
- MC6 (FP); [Table 243 \[MC6 Error Signatures\]](#).

**Table 49: Error Code Types**

| Error Code          | Error Code Type       | Description                                                                                                                                                          |
|---------------------|-----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 0000 0000 0001 TTLL | TLB                   | TT = Transaction Type<br>LL = Cache Level                                                                                                                            |
| 0000 0001 RRRR TTLL | Memory                | Errors in the cache hierarchy (not in NB)<br>RRRR = Memory Transaction Type<br>TT = Transaction Type<br>LL = Cache Level                                             |
| 0000 1PPT RRRR IILL | Bus                   | General bus errors including link and DRAM<br>PP = Participation Processor<br>T = Timeout<br>RRRR = Memory Transaction Type<br>II = Memory or IO<br>LL = Cache Level |
| 0000 01UU 0000 0000 | Internal Unclassified | Internal unclassified errors<br>UU = Internal Error Type                                                                                                             |

**Table 50: Error codes: transaction type (TT)**

| TT | Transaction Type   |
|----|--------------------|
| 00 | Instr: Instruction |
| 01 | Data               |
| 10 | Gen: Generic       |
| 11 | Reserved           |

**Table 51: Error codes: cache level (LL)**

| LL | Cache Level |
|----|-------------|
| 00 | Reserved    |
| 01 | L1: Level 1 |



**Table 51: Error codes: cache level (LL)**

| LL | Cache Level |
|----|-------------|
| 10 | L2: Level 2 |
| 11 | LG: Generic |

**Table 52: Error codes: memory transaction type (RRRR)**

| RRRR | Memory Transaction Type              |
|------|--------------------------------------|
| 0000 | Gen: Generic. Includes scrub errors. |
| 0001 | RD: Generic Read                     |
| 0010 | WR: Generic Write                    |
| 0011 | DRD: Data Read                       |
| 0100 | DWR: Data Write                      |
| 0101 | IRD: Instruction Fetch               |
| 0110 | Prefetch                             |
| 0111 | Evict                                |
| 1000 | Snoop (Probe)                        |

**Table 53: Error codes: participation processor (PP)**

| PP | Participation Processor                             |
|----|-----------------------------------------------------|
| 00 | SRC: Local node originated the request              |
| 01 | RES: Local node responded to the request            |
| 10 | OBS: Local node observed the error as a third party |
| 11 | Generic                                             |

**Table 54: Error codes: memory or IO (II)**

| II | Memory or IO       |
|----|--------------------|
| 00 | Mem: Memory Access |
| 01 | Reserved           |
| 10 | IO: IO Access      |
| 11 | Gen: Generic       |

**Table 55: Error codes: Internal Error Type (UU)**

| UU | Internal Error Type     |
|----|-------------------------|
| 00 | Reserved                |
| 01 | Reserved                |
| 10 | HWA: Hardware Assertion |
| 11 | Reserved                |

### 2.15.1.6 Handling Machine Check Exceptions

A machine check handler is invoked to handle an exception for a particular core. Because MCA registers are generally not shared among cores, the handler does not need to coordinate register usage with handler instances

on other cores. Those few MCA registers which are shared are noted in the register description. (See also [2.4.2.1 \[Registers Shared by Cores in a Compute Unit\]](#).)

For access to the NB MCA registers, [D18F3x44\[NbMcaToMstCpuEn\]](#) allows a single core (the NBC) to access the registers through MSR space without contention from other cores. This organization of registers on a per core basis allows independent execution, simplifies exception handling, and reduces the number of conditions which are globally fatal.

At a minimum, the machine check handler must be capable of logging error information for later examination. The handler should log as much information as is needed to diagnose the error.

More thorough exception handler implementations can analyze errors to determine if each error is recoverable by software. If a recoverable error is identified, the exception handler can attempt to correct the error and restart the interrupted program. An error may not be recoverable for the process or virtual machine it directly affects, but may be containable, so that other processes or virtual machines in the system are unaffected and system operation is recovered; see [2.15.1.6.1 \[Differentiation Between System-Fatal and Process-Fatal Errors\]](#).

Machine check exception handlers that attempt to recover must be thorough in their analysis and the corrective actions they take. The following guidelines should be used when writing such a handler:

- Data collection:
  - All status registers in all error reporting banks must be examined to identify the cause of the machine check exception.
    - Read [MSR0000\\_0179\[Count\]](#) to determine the number of status registers visible to the core. The status registers are numbered from 0 to one less than the value found in [MSR0000\\_0179\[Count\]](#). For example, if the Count field indicates five status registers are supported, they are numbered MC0\_STATUS to MC4\_STATUS. These are generically referred to as MCi\_STATUS.
    - Check the valid bit in each status register (MCi\_STATUS[Val]). The remainder of the status register should be examined only when its valid bit is set.
    - When identifying the error condition and determining how to handle the error, portable exception handlers should examine the following MCi\_STATUS fields: ErrorCode, UC, PCC, CECC, UECC, Deferred, Poison. The expected settings of these and other fields in MCi\_STATUS are identified in the error signatures tables which accompany the descriptions of each MCA status register. See [2.15.1.5 \[Error Code\]](#) for a discussion of error codes and pointers to the error signatures tables.
      - MCi\_STATUS[ErrorCodeExt] should generally not be used by portable code to identify the error condition because it is model specific. ErrorCodeExt is useful in determining the error sub-type for root cause analysis.
    - Error handlers should collect all available MCA information (status register, address register, miscellaneous register, etc.), but should only interrogate details to the level which affects their actions. Lower level details may be useful for diagnosis and root cause analysis, but not for error handling.
- Recovery:
  - Check the valid MCi\_STATUS registers to see if error recovery is possible.
    - Error recovery is not possible when the processor context corrupt indicator (MCi\_STATUS[PCC]) is set to 1.
      - The error overflow status indicator (MCi\_STATUS[Overflow]) does not indicate whether error recovery is possible. See [2.15.1.3.2 \[Error Logging During Overflow\]](#).
    - If error recovery is not possible, the handler should log the error information and return to the operating system for system termination.
  - Check MCi\_STATUS[UC] to see if the processor corrected the error. If UC is set, the processor did not correct the error, and the exception handler must correct the error prior to attempting to restart the interrupted program. If the handler cannot correct the error, it should log the error information and return to

the operating system. If the error affects only process data, it may be possible to terminate only the affected process or virtual machine. If the error affects processor state, continued use of that processor should not occur. See individual error descriptions for further guidance.

- If [MSR0000\\_017A](#)[RIPV] is set, the interrupted program can be restarted reliably at the instruction pointer address pushed onto the exception handler stack if any uncorrected error has been corrected by software. If RIPV is clear, the interrupted program cannot be restarted reliably, although it may be possible to restart it for debugging purposes. As long as PCC is clear, it may be possible to terminate only the affected process or virtual machine.
- When logging errors, particularly those that are not recoverable, check [MSR0000\\_017A](#)[EIPV] to see if the instruction pointer address pushed onto the exception handler stack is related to the machine check. If EIPV is clear, the address is not ensured to be related to the error.
- See [2.15.1.6.1 \[Differentiation Between System-Fatal and Process-Fatal Errors\]](#) for more explanation on the relationship between PCC, RIPV, and EIPV.
- Exit:
  - When an exception handler is able to successfully log an error condition, clear the `MCi_STATUS` registers prior to exiting the machine check handler. Software is responsible for clearing at least `MCi_STATUS[Val]`.
  - Prior to exiting the machine check handler, be sure to clear [MSR0000\\_017A](#)[MCIP]. MCIP indicates that a machine check exception is in progress. If this bit is set when another machine check exception occurs in the same core, the processor enters the shutdown state.

Additional machine check handler portability can be added by having the handler use the `CPUID` instruction to identify the processor and its capabilities. Implementation specific software can be added to the machine check exception handler based on the processor information reported by `CPUID`.

In cases where sync flood is the recommended response to a particular error, a machine check exception cannot be used in lieu of the sync flood to stop the propagation of potentially bad data.

#### 2.15.1.6.1 Differentiation Between System-Fatal and Process-Fatal Errors

The bits `MCi_STATUS[PCC]`, [MSR0000\\_017A](#)[RIPV], and [MSR0000\\_017A](#)[EIPV] form a hierarchy, used by software to determine the degree of corruption and recoverability in the system.

[Table 56](#) shows how these bits are interpreted.

**Table 56: Error Scope Hierarchy**

| PCC | UC | RIPV | EIPV | Deferred | Poison | Comments                                                                                                                                                                                                   |
|-----|----|------|------|----------|--------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1   | 1  | -    | -    | -        | -      | <b>System fatal error.</b> Signaled via machine check exception, action required. Error has corrupted system state (PCC=1). The error is fatal to the system and the system processing must be terminated. |
| 0   | 1  | 1    | 1    | -        | -      |                                                                                                                                                                                                            |

**Table 56: Error Scope Hierarchy**

| PCC | UC | RIPV | EIPV | Deferred | Poison | Comments                                                                                                                                                                                                                                                                                                                                                                                                                          |
|-----|----|------|------|----------|--------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 0   | 1  | 0    | -    | -        | 0/1    | <b>Hardware uncorrected, software containable error.</b><br>Signaled via machine check exception, action required. The error is confined to the process, however the process cannot be restarted even if the uncorrected error is corrected by software.<br><br>Poison=1; the error is due to consumption of poison data. If the affected process or virtual machine is terminated, the system may continue operation.            |
| 0   | 0  | -    | -    | 1        | 0      | <b>Deferred error.</b> Action optional. A latent error has been discovered, but not yet consumed; a machine check exception will be generated if the affected data is consumed. Error handling software may attempt to correct this data error, or prevent access by processes which map the data, or make the physical resource containing the data inaccessible.<br>Note: May be detected on a demand access or a scrub access. |
| 0   | 0  | -    | -    | 0        | 0      | <b>Corrected error.</b><br>Signaled via error thresholding mechanisms (2.15.1.7 [Error Thresholding]); no action required.                                                                                                                                                                                                                                                                                                        |

### 2.15.1.7 Error Thresholding

For some types of errors, the hardware maintains counts of the number of errors. When the counter reaches a programmable threshold, an event may optionally be triggered to signal software. This is known as error thresholding. The primary purpose of error thresholding is to help software recognize an excessive rate of errors, which may indicate marginal or failing hardware. This information can be used to make decisions about deconfiguring hardware or scheduling service actions. Counts are incremented for corrected, deferred, and uncorrected errors.

The error thresholding hardware counts only the number of errors; it is up to software to track the errors reported over time in order to determine the rate of errors. Thresholding gives error counts on groups of resources. In order to make decisions on individual resources, a finer granularity of error information, such as MCA information for specific errors, must be utilized in order to obtain more accurate counts and to limit the scope of actions to affected hardware.

Thresholding is performed for “Error Threshold Groups” identified in the list below. For all error threshold groups, some number of corrected errors is expected and normal. There are numerous factors influencing error rates, including temperature, voltage, operating speed, and geographic location. In order to accommodate the various factors, including software latency to respond and track the error thresholding, additional guardband above the normal rates is recommended before error rates are considered abnormal for purposes of hardware action.

The {MC0, MC1, MC2, MC5} error thresholding banks maintains counters, but do not provide interrupts when the threshold is reached; these counters must be polled.

Error thresholding groups:

- MC0
  - MC0 errors are counted and polled via [MSR0000\\_0403](#).
  - MC0 errors are listed in [Table 220 \[MC0 Error Descriptions\]](#).
- MC1
  - MC1 errors are counted and polled via [MSR0000\\_0407](#).
  - MC1 errors are listed in [Table 223 \[MC1 Error Descriptions\]](#).
- MC2
  - MC2 errors are counted and polled via [MSR0000\\_040B](#).
  - MC2 errors are listed in [Table 227 \[MC2 Error Descriptions\]](#).
- DRAM (MC4)
  - Memory errors are counted and polled or reported via [MSR0000\\_0413](#).

DRAM errors are the errors listed in [Table 231 \[MC4 Error Signatures, Part 1\]](#) as “D” (DRAM) in the ETG (Error Threshold Group) column.

- Operating systems can avoid or stop using memory pages with excessive errors.
- Links (MC4)
  - Link errors are counted and polled or reported via [MSRC000\\_0408](#).
  - Link errors are the errors listed in [Table 231 \[MC4 Error Signatures, Part 1\]](#) as “L” (Cache) in the ETG (Error Threshold Group) column.
  - For a link exhibiting excessive errors, it may be possible to reduce errors by lowering the link frequency or reducing the link width (if a bad lane can be avoided). See [2.11 \[Root Complex\]](#) for details and restrictions on configuring links.
- MC5
  - MC5 errors are counted and polled via [MSR0000\\_0417](#).
  - MC5 errors are listed in [Table 240 \[MC5 Error Signatures\]](#).

In rare circumstances, such as two simultaneous errors in the same error thresholding group, it is possible for one error not to increment the counter. In these conditions, MCi\_STATUS[Overflow] may indicate that an overflow occurred, but the error counter may only indicate one error.

### 2.15.1.8 Scrub Rate Considerations

This section gives guidelines for the scrub rate settings available in [D18F3x58 \[Scrub Rate Control\]](#). Scrubbers are used to periodically read cacheline sized data locations and associated tags. There are two primary benefits to scrubbing. First, scrubbing corrects any corrected errors which are discovered before they can migrate into uncorrected errors. This is particularly important for soft errors, which are caused by external sources such as radiation and which are temporary conditions which do not indicate malfunctioning hardware. Second, scrubbers help identify marginal or failed hardware by finding and logging repeated errors at the same locations (see also [2.15.1.7 \[Error Thresholding\]](#)).

There are many factors which influence scrub rates. Among these are:

- The size of memory or cache to be scrubbed
- Resistance to upsets
- Geographic location and altitude
- Alpha particle contribution of packaging
- Performance sensitivity
- Risk aversion

The baseline recommendations in [Table 57](#) are intended to provide excellent protection at most geographic locations, while having no measurable effect on performance. Adjustments may be necessary due to special circumstances. Refer to JEDEC standards for guidelines on adjusting for geographic location.

**Table 57: Recommended Scrub Rates per Node**

| Register            | Memory Size per Node (GB) | Register Setting | Scrub Rate |
|---------------------|---------------------------|------------------|------------|
| D18F3x58[DramScrub] | 0 GB == Size              | 00h              | Disabled   |
|                     | 0 GB < Size <= 1 GB       | 12h              | 5.24 ms    |
|                     | 1 GB < Size <= 2 GB       | 11h              | 2.62 ms    |
|                     | 2 GB < Size <= 4 GB       | 10h              | 1.31 ms    |
|                     | 4 GB < Size <= 8 GB       | 0Fh              | 655.4 us   |
|                     | 8 GB < Size <= 16 GB      | 0Eh              | 327.7 us   |
|                     | 16 GB < Size <= 32 GB     | 0Dh              | 163.8 us   |
|                     | 32 GB < Size <= 64 GB     | 0Ch              | 81.9 us    |
|                     | 64 GB < Size <= 128 GB    | 0Bh              | 41.0 us    |
|                     | 128 GB < Size <= 256 GB   | 0Ah              | 20.5 us    |
|                     | 256 GB < Size             | 09h              | 10.2 us    |

For steady state operation, finding a range of useful scrub rates may be performed by selecting a scrub rate which is high enough to give good confidence about protection from accumulating errors and low enough that it has no measurable effect on performance. The above baselines are made to maximize error coverage without affecting performance and not based on specific processor soft error rates.

For low power states in which the processor core is halted, the power management configuration may affect scrubbing; see [2.8.3 \[Memory Scrubbers\]](#).

### 2.15.1.9 Error Diagnosis

This section describes generalized information and algorithms for diagnosing errors. The primary goal of diagnosis is to identify the failing component for repair purposes. The secondary goal is to identify the smallest possible sub-component for deallocation, deconfiguration, or design/manufacturing root cause analysis.

*Indictment* means identifying the part in error. The simplest form of indictment is *self-indictment*, where the bank reporting the error is the faulty unit. The next simplest form of indictment is *eyewitness indictment*, where the faulty unit is not the bank reporting the error, but is identified unambiguously. Both of these forms can be considered direct indictment; the information for indictment is contained in the MCA error information. If an error is not directly indicted, then identifying the faulty unit is more difficult and may not be an explicit part of the error log.

In general, an address logged in the MCA is useful for direct indictment only if the address identifies a physical location in error, such as a cache index. Logical addresses, while identifying the data, do not identify the location of the data.

If possible, physical storage locations in caches should be checked to determine whether the error is a soft error (a temporary upset of the stored value) or a hard fault (malfunctioning hardware). A location which has had a soft error can be corrected by writing a new value to the location; a reread of the location should see the new value. Hard faults cannot be corrected by writing a new value; the hardware persistently returns the previous value. If such checking is not possible, a grossly simplifying assumption can be made that uncorrected errors are hard and corrected errors are soft. Repeated corrected errors from the same location are an indication that the fault is actually hard.

Determining whether corrected errors represent a hard fault or a soft error requires understanding the access

patterns and any attempts to correct the faulty data in place. An attempt to correct the data in place creates two *epochs*, one before the correction event, and one after. If an error is seen at the same location in two different epochs (especially back-to-back epochs), it is more likely that the cause is a hard fault, since the error has persisted or repeated through an in place correction. The more epochs in which a error is seen, the higher the likelihood of it being caused by a hard fault.

As an example, consider a corrected error found during a read from DRAM. If the DRAM redirect scrubber is enabled (**D18F3x5C**[ScrubReDirEn]), the data in error is corrected in place, and this event conceptually creates a new epoch. If the original fault was due to a soft error, a read of the same data in the new epoch should not encounter a data error. If the original fault was due to a hard fault (e.g., a stuck bit), a read of the data in the new epoch will likely result in another corrected or uncorrected error.

There are numerous correction events that can be used to separate time periods into epochs. These include DRAM redirect scrubs, DRAM sequential scrubs, cache scrubs, cache writes, cache flushes, resets, and others.

#### 2.15.1.9.1 Common Diagnosis Information

A common set of diagnosis information is useful for many problems. [Table 58](#) indicates the minimum set of generally useful diagnostic information that should be collected by software, unless the specifics of the problem are known to be narrower, based on the error code or other information.

It is useful to collect configuration information to ensure that the behavior is not caused by misconfiguration.

**Table 58: Registers Commonly Used for Diagnosis**

| MCA Bank | Status                                       | Configuration                                |
|----------|----------------------------------------------|----------------------------------------------|
| MC0      | MSR0000_0401<br>MSR0000_0402<br>MSR0000_0403 | MSR0000_0400<br>MSRC001_1022<br>MSRC001_0044 |
| MC1      | MSR0000_0405<br>MSR0000_0406<br>MSR0000_0407 | MSR0000_0404                                 |
| MC2      | MSR0000_0409<br>MSR0000_040A<br>MSR0000_040B | MSR0000_0408<br>MSRC001_0046<br>MSRC001_1023 |
| MC3      | Reserved                                     | Reserved                                     |

**Table 58: Registers Commonly Used for Diagnosis**

| MCA Bank | Status                                                                               | Configuration                                                                                             |
|----------|--------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------|
| MC4      | MSR0000_0411<br>MSR0000_0412<br>MSR0000_0413<br>MSRC000_0408<br>D18F3x54<br>D18F2xAC | MSR0000_0410<br>MSRC001_0048<br>D18F3x40<br>D18F3x44<br>D18F3xE4<br>D18F3xE8<br>MSRC001_001F<br>D18F3x180 |
| MC5      | MSR0000_0415<br>MSR0000_0416<br>MSR0000_0417                                         | MSR0000_0414                                                                                              |
| MC6      | MSR0000_0419<br>MSR0000_041A<br>MSR0000_041B                                         | MSR0000_0418<br>MSRC001_004A                                                                              |

If examining MCA registers after startup, determine the cause of the startup:

- INIT; [D18F0x6C\[InitDet\]](#).
- Cold reset; [D18F0x6C\[ColdRstDet\]](#).
- Warm reset; if not INIT or cold reset.

To see if a link failure occurred, examine [D18F0x\[E4,C4,A4,84\]\[LinkFail\]](#). If set, look for additional information:

- Receipt of a sync, such as during a sync flood, saves a status of Sync Error in MC4\_STATUS.
- CRC error saves a status of CRC Error in MC4\_STATUS. See [D18F0x\[E4,C4,A4,84\]\[CrcErr,CrcFloodEn\]](#).
- Link not present does not save status in MC4\_STATUS. See [D18F0x\[E4,C4,A4,84\]\[InitComplete\]](#).

Other registers may be needed depending on the specific error symptoms.

### 2.15.1.10 Deferred Errors and Data Poisoning

Deferred errors indicate error conditions which could not be corrected, but which require no action (i.e., action optional). Data poisoning marks data which has encountered an uncorrectable error, so that it can be tracked until it is consumed or discarded. Together, data poisoning and deferred errors provide an infrastructure for reducing the severity of errors and the number of system outages for some classes of errors.

Processor cores create poison data and deferred errors as identified in the Error Signatures tables. When poison data or data with an uncorrectable ECC error is consumed, a machine check exception for an uncorrected error is signaled (MCi\_STATUS[UC]). If the data is poison, MCi\_STATUS[Poison] is also set. The NB converts any poison data sent from the core to a machine check exception with error type Compute Unit Data Error. To understand the cause of a machine check exception due to Compute Unit Data Error, examine the core MCA status registers for deferred errors.

The deferred error is logged in the MCA registers for diagnostic purposes at the time the error is discovered



and the data is poisoned. This deferred error can help identify the source of the error. The deferred error is logged independently of any associated poison data machine check. For example, it is possible for a cache eviction to result in a deferred error associated with the cache, and a corresponding machine check exception from the NB which receives the data.

## 2.15.2 DRAM ECC Considerations

DRAM is protected by an error correcting code (ECC). The DRAM error correcting code features an ECC word formed by a symbol based code. The x4 code uses thirty-six 4-bit symbols to make a 144-bit ECC word made up of 128 data bits and 16 check bits.

The x4 code is a single symbol correcting (SSC) and a double symbol detecting (DSD) code. This means the x4 code is able to correct 100% of single symbol errors (any bit error combination within one symbol), and detect 100% of double symbol errors (any bit error combination within two symbols).

Systems supporting ECC and non-ECC memory regions should use the non-ECC memory for the Frame Buffer only.

### 2.15.2.1 ECC Syndromes

For memory errors, the sections below describe how to find the DIMM in error. The process varies slightly according to the ECC code in use. To determine which ECC code is being used, see [D18F3x180\[EccSymbolSize\]](#).

For correctable errors, the DIMM in error is uniquely identified by the error address ([MSR0000\\_0412\[ErrAddr\]](#)) and the ECC syndrome ([MSR0000\\_0411\[Syndrome\[15:8\]\]](#) and [MSR0000\\_0411\[Syndrome\[7:0\]\]](#)). The error address maps to the two DIMMs composing the 128-bit line, and the ECC syndrome identifies one DIMM by identifying the symbol within the line.

#### 2.15.2.1.1 x4 ECC

The use of x4 ECC is indicated in [D18F3x180\[EccSymbolSize\]](#).

The syndrome field uniquely identifies the failing bit positions of a correctable ECC error. Only syndromes identified by [Table 59](#) are correctable by the error correcting code.

Symbols 00h-0Fh map to data bits 0-63; symbols 10h-1Fh map to data bits 64-127; symbols 20-21h map to ECC check bits for data bits 0-63; symbols 22-23h map to ECC check bits for data bits 64-127.

To use [Table 59](#), first find the 16-bit syndrome value in the table. This is performed by using low order 4 bits of the syndrome to select the appropriate error bitmask column. The entire four digit syndrome should then be in one of the rows of that column. The Symbol In Error row indicates which symbol, and therefore which DIMM has the error, and the column indicates which bits within the symbol.

For example, if the ECC syndrome is 6913h, then symbol 05h has the error, and bits 0 and 1 within that symbol are corrupted, since the syndrome is in column 3h (0011b). Symbol 05h maps to bits 23-20, so the corrupted bits are 20 and 21.

**Table 59: x4 ECC Correctable Syndromes**

| Symbol<br>In Error | Error Bitmask |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
|--------------------|---------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
|                    | 0001          | 0010 | 0011 | 0100 | 0101 | 0110 | 0111 | 1000 | 1001 | 1010 | 1011 | 1100 | 1101 | 1110 | 1111 |
| Data 0             | e821          | 7c32 | 9413 | bb44 | 5365 | c776 | 2f57 | dd88 | 35a9 | a1ba | 499b | 66cc | 8eed | 1afe | f2df |
| Data 1             | 5d31          | a612 | fb23 | 9584 | c8b5 | 3396 | 6ea7 | eac8 | b7f9 | 4cda | 11eb | 7f4c | 227d | d95e | 846f |
| Data 2             | 0001          | 0002 | 0003 | 0004 | 0005 | 0006 | 0007 | 0008 | 0009 | 000a | 000b | 000c | 000d | 000e | 000f |
| Data 3             | 2021          | 3032 | 1013 | 4044 | 6065 | 7076 | 5057 | 8088 | a0a9 | b0ba | 909b | c0cc | e0ed | f0fe | d0df |
| Data 4             | 5041          | a082 | f0c3 | 9054 | c015 | 30d6 | 6097 | e0a8 | b0e9 | 402a | 106b | 70fc | 20bd | d07e | 803f |
| Data 5             | be21          | d732 | 6913 | 2144 | 9f65 | f676 | 4857 | 3288 | 8ca9 | e5ba | 5b9b | 13cc | aded | c4fe | 7adf |
| Data 6             | 4951          | 8ea2 | c7f3 | 5394 | 1ac5 | dd36 | 9467 | a1e8 | e8b9 | 2f4a | 661b | f27c | bb2d | 7cde | 358f |
| Data 7             | 74e1          | 9872 | ec93 | d6b4 | a255 | 4ec6 | 3a27 | 6bd8 | 1f39 | f3aa | 874b | bd6c | c98d | 251e | 51ff |
| Data 8             | 15c1          | 2a42 | 3f83 | cef4 | db35 | e4b6 | f177 | 4758 | 5299 | 6d1a | 78db | 89ac | 9c6d | a3ee | b62f |
| Data 9             | 3d01          | 1602 | 2b03 | 8504 | b805 | 9306 | ae07 | ca08 | f709 | dc0a | e10b | 4f0c | 720d | 590e | 640f |
| Data 10            | 9801          | ec02 | 7403 | 6b04 | f305 | 8706 | 1f07 | bd08 | 2509 | 510a | c90b | d60c | 4e0d | 3a0e | a20f |
| Data 11            | d131          | 6212 | b323 | 3884 | e9b5 | 5a96 | 8ba7 | 1cc8 | cdf9 | 7eda | afeb | 244c | f57d | 465e | 976f |
| Data 12            | e1d1          | 7262 | 93b3 | b834 | 59e5 | ca56 | 2b87 | dc18 | 3dc9 | ae7a | 4fab | 642c | 85fd | 164e | f79f |
| Data 13            | 6051          | b0a2 | d0f3 | 1094 | 70c5 | a036 | c067 | 20e8 | 40b9 | 904a | f01b | 307c | 502d | 80de | e08f |
| Data 14            | a4c1          | f842 | 5c83 | e6f4 | 4235 | 1eb6 | ba77 | 7b58 | df99 | 831a | 27db | 9dac | 396d | 65ee | c12f |
| Data 15            | 11c1          | 2242 | 3383 | c8f4 | d935 | eab6 | fb77 | 4c58 | 5d99 | 6e1a | 7fdb | 84ac | 956d | a6ee | b72f |
| Data 16            | 45d1          | 8a62 | cfb3 | 5e34 | 1be5 | d456 | 9187 | a718 | e2c9 | 2d7a | 68ab | f92c | bcfd | 734e | 369f |
| Data 17            | 63e1          | b172 | d293 | 14b4 | 7755 | a5c6 | c627 | 28d8 | 4b39 | 99aa | fa4b | 3c6c | 5f8d | 8d1e | eeff |
| Data 18            | b741          | d982 | 6ec3 | 2254 | 9515 | fbdb | 4c97 | 33a8 | 84e9 | ea2a | 5d6b | 11fc | a6bd | c87e | 7f3f |
| Data 19            | dd41          | 6682 | bbc3 | 3554 | e815 | 53d6 | 8e97 | 1aa8 | c7e9 | 7c2a | a16b | 2ffc | f2bd | 497e | 943f |
| Data 20            | 2bd1          | 3d62 | 16b3 | 4f34 | 64e5 | 7256 | 5987 | 8518 | aec9 | b87a | 93ab | ca2c | e1fd | f74e | dc9f |
| Data 21            | 83c1          | c142 | 4283 | a4f4 | 2735 | 65b6 | e677 | f858 | 7b99 | 391a | badb | 5cac | df6d | 9dee | 1e2f |
| Data 22            | 8fd1          | c562 | 4ab3 | a934 | 26e5 | 6c56 | e387 | fe18 | 71c9 | 3b7a | b4ab | 572c | d8fd | 924e | 1d9f |
| Data 23            | 4791          | 89e2 | ce73 | 5264 | 15f5 | db86 | 9c17 | a3b8 | e429 | 2a5a | 6dcb | f1dc | b64d | 783e | 3faf |
| Data 24            | 5781          | a9c2 | fe43 | 92a4 | c525 | 3b66 | 6ce7 | e3f8 | b479 | 4a3a | 1dbb | 715c | 26dd | d89e | 8f1f |
| Data 25            | bf41          | d582 | 6ac3 | 2954 | 9615 | fed6 | 4397 | 3ea8 | 81e9 | eb2a | 546b | 17fc | a8bd | c27e | 7d3f |
| Data 26            | 9391          | e1e2 | 7273 | 6464 | f7f5 | 8586 | 1617 | b8b8 | 2b29 | 595a | cacb | dcdc | 4f4d | 3d3e | aeaf |
| Data 27            | cce1          | 4472 | 8893 | fdb4 | 3155 | b9c6 | 7527 | 56d8 | 9a39 | 12aa | de4b | ab6c | 678d | ef1e | 23ff |
| Data 28            | a761          | f9b2 | 5ed3 | e214 | 4575 | 1ba6 | bcc7 | 7328 | d449 | 8a9a | 2dfb | 913c | 365d | 688e | cfef |
| Data 29            | ff61          | 55b2 | aad3 | 7914 | 8675 | 2ca6 | d3c7 | 9e28 | 6149 | cb9a | 34fb | e73c | 185d | b28e | 4def |
| Data 30            | 5451          | a8a2 | fcf3 | 9694 | c2c5 | 3e36 | 6a67 | ebe8 | bfb9 | 434a | 171b | 7d7c | 292d | d5de | 818f |
| Data 31            | 6fc1          | b542 | da83 | 19f4 | 7635 | acb6 | c377 | 2e58 | 4199 | 9b1a | f4db | 37ac | 586d | 82ee | ed2f |
| Check0             | be01          | d702 | 6903 | 2104 | 9f05 | f606 | 4807 | 3208 | 8c09 | e50a | 5b0b | 130c | ad0d | c40e | 7a0f |
| Check1             | 4101          | 8202 | c303 | 5804 | 1905 | da06 | 9b07 | ac08 | ed09 | 2e0a | 6f0b | f40c | b50d | 760e | 370f |
| Check2             | c441          | 4882 | 8cc3 | f654 | 3215 | bed6 | 7a97 | 5ba8 | 9fe9 | 132a | d76b | adfc | 69bd | e57e | 213f |

**Table 59: x4 ECC Correctable Syndromes**

| Symbol<br>In Error | Error Bitmask |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
|--------------------|---------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
|                    | 0001          | 0010 | 0011 | 0100 | 0101 | 0110 | 0111 | 1000 | 1001 | 1010 | 1011 | 1100 | 1101 | 1110 | 1111 |
| Check3             | 7621          | 9b32 | ed13 | da44 | ac65 | 4176 | 3757 | 6f88 | 19a9 | f4ba | 829b | b5cc | c3ed | 2efe | 58df |

### 2.15.3 Error Injection and Simulation

*Error injection* allows the introduction of errors into the system for test and debug purposes. See the following sections for error injection details:

- DRAM: See [2.15.3.1 \[DRAM Error Injection\]](#).
- Link:
  - [D18F3x44](#)[GenLinkSel, GenSubLinkSel, GenCrcErrByte1, GenCrcErrByte0].

*Error simulation* involves creating the appearance to software that an error occurred, and can be used to debug machine check interrupt handlers. This is performed by manually setting the MCA registers with desired values, and then driving the software via INT18. See [MSRC001\\_0015](#)[McStatusWrEn] for making MCA registers writable for non-zero values. When McStatusWrEn is set, privileged software can write non-zero values to the specified registers without generating exceptions, and then simulate a machine check using the INT18 instruction (INTn instruction with an operand of 18). Setting a reserved bit in these registers does not generate an exception when this mode is enabled. However, setting a reserved bit may result in undefined behavior.

#### 2.15.3.1 DRAM Error Injection

This section gives details and examples on injecting errors into DRAM using [D18F3xBC\\_x8](#) [DRAM ECC]. The intent of DRAM error injection is to cause a discrepancy between the stored data and the stored ECC value. Therefore, DRAM error injection is only possible on DRAM which supports ECC, and in which [D18F2x90\\_dct\[3:0\]](#)[DimmEccEn] and [D18F3x44](#)[DramEccEn] are set.

The memory subsystem operates on 64-byte cachelines. The following fields are used to set how the cacheline is to be corrupted in DRAM:

- [D18F3xB8](#)[ArrayAddress] selects a cacheline quadrant (16-byte section) of the cacheline. Each cacheline quadrant is protected by an ECC word. Note that there are special requirements for which bits are used to specify the target quadrant.
- [D18F3xBC\\_x8](#)[ErrInjEn] selects a 16-bit word of the cacheline quadrant selected in ArrayAddress. The 16-bit word identified as ECC[15:0] refers to the bits which store the ECC value; the other 16-bit words address the data on which the ECC is calculated. One or more of these 16-bit words can be selected, and the error bitmask indicated in EccVector is applied to each of the selected words.
- [D18F3xBC\\_x8](#)[EccVector] is a bitmask which selects the individual bits to be corrupted in the 16-bit words selected by ErrInjEn. When selecting the bits to be corrupted for correctable or uncorrectable errors, consider the ECC scheme being used, including symbol size; see [2.15.2 \[DRAM ECC Considerations\]](#) for more details. Note that corrupting more than two symbols may exceed the limits of the ECC to detect the errors; for testing purposes it is recommended that no more than two symbols be corrupted in a single cacheline quadrant.

The distinction between [D18F3xBC\\_x8](#)[DramErrEn] and [D18F3xBC\\_x8](#)[EccWrReq] is that DramErrEn is used to continuously inject errors on every write. This bit is set and cleared by software. EccWrReq is used to inject an error on only one write. This bit is set by software and is cleared by hardware after the error is injected.

When performing DRAM error injection on multi-node systems, [D18F3xB8](#) and [D18F3xBC\\_x8](#) of the NB to which the memory is attached must be programmed.

The following can be used to trigger the injection:

- The memory address is not an explicit parameter of the error injection interface. Once the error injection registers [D18F3xB8](#) and [D18F3xBC](#) are set, the next non-cached access of the appropriate type will trigger the mechanism and apply it to the accessed address. The access should be non-cached so that it is ensured to be seen by the memory controller. Possible methods to ensure a non-cached access include using the appropriate MTRR to set the memory type to UC or turning off caches. If it is important to know the address, then system activity must be quiesced so that the access can take place under careful software control. Once the error injection pattern is set in [D18F3xB8](#) and [D18F3xBC\\_x8](#):
  - Set either [D18F3xBC\\_x8\[EccWrReq\]](#) or [D18F3xBC\\_x8\[DramErrEn\]](#) to enable the triggering mechanism.
  - The next non-cached access of the appropriate type will trigger the mechanism and apply it to the accessed address.

After the error is injected, the data must be accessed in order for the error detection to be triggered. The error address logged in [MSR0000\\_0412](#) will correspond to the cacheline quadrant that contains the error.

When using [MSR0000\\_0411](#) to read `MC4_STATUS` after an error injection and subsequent error detection, be aware that the setting of [D18F3x44\[NbMcaToMstCpuEn\]](#) can cause different cores to see different values. Alternatively, `MC4_STATUS` can be read through the PCI-defined configuration space aliases [D18F3x4C](#) and [D18F3x48](#), which do not return different values to different cores, regardless of the setting of [D18F3x44\[NbMcaToMstCpuEn\]](#).

#### Example 1: Injecting a correctable error:

- Program error pattern:
  - [D18F3xB8\[ArraySelect\]](#)=1000b // select DRAM as target
  - [D18F3xB8\[ArrayAddress\]](#)=000000000b // select 16-byte (128-bit) section
  - [D18F3xBC\\_x8\[ErrInjEn\]](#)=000000001b // select 16-bit word in 16-byte section
  - [D18F3xBC\\_x8\[EccRdReq\]](#)=0 // not a read request
  - [D18F3xBC\\_x8\[EccVector\]](#)=0001h // set bitmask to inject error into only one symbol
- Program error trigger:
  - [D18F3xBC\\_x8\[DramErrEn\]](#)=0 // inject only a single error
  - [D18F3xBC\\_x8\[EccWrReq\]](#)=1 // a write request; enable injection on next write
- Clean up // if programmed for continuous errors
  - [D18F3xBC\\_x8\[DramErrEn\]](#)=0 // inject only a single error

### 2.15.4 GIO RAS

The following register should be programmed to enable RAS features in the GIO.

- Program [D0F0x98\\_x07\[SyncFloodOnParityErr\]](#)=1

### 3 Registers

This section provides detailed field definitions for the core register sets in the processor.

#### 3.1 Register Descriptions and Mnemonics

Each register in this document is referenced with a mnemonic. Each mnemonic is a concatenation of the register-space indicator and the offset of the register. Here are the mnemonics for the various register spaces:

- **IOXXX**: x86-defined input and output address space registers; XXX specifies the hexadecimal byte address of the IO instruction. This space includes IO-space configuration access registers [IOCF8 \[IO-Space Configuration Address\]](#) and [IOCFC \[IO-Space Configuration Data Port\]](#).
- **APICXX0**: APIC memory-mapped registers; XX0 is the hexadecimal byte address offset from the base address. See [2.4.9.1.2 \[APIC Register Space\]](#).
- **CPUID FnXXXX\_XXXX\_EiX[\_xYYY]**: processor capabilities information returned by the CPUID instruction. See [3.18 \[CPUID Instruction Registers\]](#). Each core may only access this information for itself.
- **MSRXXXX\_XXXX**: [MSRs](#); XXXX\_XXXX is the hexadecimal MSR number. This space is accessed through x86-defined RDMSR and WRMSR instructions. Unless otherwise specified there is one set of these registers [Per-core](#). See [2.4.1 \[Compute Unit\]](#).
- **DXFYxZZZ**: PCI-defined configuration space; X specifies the hexadecimal device number (this may be 1 or 2 digits), Y specifies the function number, and ZZZ specifies the hexadecimal byte address (this may be 2 or 3 digits); e.g., D18F3x40 specifies the register at device 18h, function 3, and address 40h. See [2.7 \[Configuration Space\]](#), for details about configuration space.
  - Some register in D18F2xXXX have the `_dct[3:0]` mnemonic suffix. See [2.9.3 \[DCT Configuration Registers\]](#).
- **IOMMUxX\_XXXX**: IOMMU memory mapped registers; X\_XXXX specifies the hexadecimal byte address offset (this may be 2 to 5 digits) from the base address register; The base address for this space is specified by [D0F2x44 \[IOMMU Base Address Low\]](#) and [D0F2x48 \[IOMMU Base Address High\]](#). See [3.16 \[IOMMU Memory Mapped Registers\]](#).
- **PMCxXXX**: core performance monitor events; XXX is the hexadecimal event counter number programmed into [MSRC001\\_020\[A,8,6,4,2,0\]\[EventSelect\]](#); See [2.6.1.1 \[Core Performance Monitor Counters\]](#).
  - When PMCxXXX is followed by `[z:y]` then `UnitMask[z:y]` is being specified.
- **NBPMCxXXX**: NB performance monitor events; XXX is the hexadecimal event counter number programmed into [MSRC001\\_024\[6,4,2,0\]\[EventSelect\]](#); See [2.6.1.2 \[NB Performance Monitor Counters\]](#).
  - When NBPMCxXXX is followed by `[z:y]` then `UnitMask[z:y]` is being specified.

Each mnemonic may specify the location of one or more registers that share the same base definition. A mnemonic that specifies more than one register will contain one or more ranges within braces. The ranges are specified as follows:

- Comma separated lists `[A,B]`: Define specific instances of a register, e.g., `D0F3x[1,0]40` defines two registers `D0F3x40` and `D0F3x140`.
- Colon separated ranges `[A:B]`: Defines all registers that contain the range between A and B. Examples:
  - `D0F3x[50:40]` defines five registers `D0F3x40`, `D0F3x44`, `D0F3x48`, `D0F3x4C`, and `D0F3x50`.
  - `D[8:2]F0x40` defines seven registers `D2F0x40`, `D3F0x40`, `D4F0x40`, `D5F0x40`, `D6F0x40`, `D7F0x40`, and `D8F0x40`.
  - `D0F0xE4_x013[2:0]_0000` defines three registers `D0F0xE4_x0130_0000`, `D0F0xE4_x0131_0000`, and `D0F0xE4_x0132_0000`.
- Colon separated ranges with an explicit step `[A:BstepC]`: Defines the registers from A to B, C defines the offset between registers., e.g., `D0F3x[50:40:step8]` defines three registers `D0F3x40`, `D0F3x48`, and `D0F3x50`.

The processor includes a single set of IO-space and configuration-space registers. However, APIC, CPUID, and MSR register spaces are implemented once per processor core. Access to IO-space and configuration space

registers may require software-level techniques to ensure that no more than one core attempts to access a register at a time.

The following is terminology found in the register descriptions.

**Table 60: Terminology in Register Descriptions**

| Term                | Definition                                                                                                                                                                                                                                                                                                                                                                                    |
|---------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| BIOS                | Software recommendation syntax. See <a href="#">3.1.2 [Software Recommendation (BIOS, SBIOS)]</a> .                                                                                                                                                                                                                                                                                           |
| SBIOS               |                                                                                                                                                                                                                                                                                                                                                                                               |
| See                 | Reference to remote definition.                                                                                                                                                                                                                                                                                                                                                               |
| Alias               | The alias keyword allows the definition of a soft link between two registers. <ul style="list-style-type: none"><li>• X is an alias of Y: X is a soft link to the register Y.</li><li>• X1, X2 are an alias of Y: Both X1 and X2 are soft links to Y.</li></ul>                                                                                                                               |
| IF                  | Allows conditional definition as a function of register fields. The syntax is: <ul style="list-style-type: none"><li>• IF (conditional-expression) THEN definition ENDIF.</li><li>• IF (conditional-expression) THEN definition ELSE definition ENDIF.</li><li>• IF (conditional-expression) THEN definition ELSEIF (conditional-expression) THEN definition ELSE definition ENDIF.</li></ul> |
| THEN                |                                                                                                                                                                                                                                                                                                                                                                                               |
| ELSEIF              |                                                                                                                                                                                                                                                                                                                                                                                               |
| ELSE                |                                                                                                                                                                                                                                                                                                                                                                                               |
| ENDIF               |                                                                                                                                                                                                                                                                                                                                                                                               |
| Access Types        |                                                                                                                                                                                                                                                                                                                                                                                               |
| Read                | Capable of being read by software.                                                                                                                                                                                                                                                                                                                                                            |
| Read-only           | Capable of being read but not written by software.                                                                                                                                                                                                                                                                                                                                            |
| Write               | Capable of being written by software.                                                                                                                                                                                                                                                                                                                                                         |
| Write-only          | Write-only. Capable of being written by software. Reads are undefined.                                                                                                                                                                                                                                                                                                                        |
| Read-write          | Capable of being written by software and read by software.                                                                                                                                                                                                                                                                                                                                    |
| Set-by-hardware     | Register field is set high by hardware, set low by hardware, or updated by hardware.                                                                                                                                                                                                                                                                                                          |
| Cleared-by-hardware |                                                                                                                                                                                                                                                                                                                                                                                               |
| Updated-by-hardware |                                                                                                                                                                                                                                                                                                                                                                                               |
| Updated-by-SMU      |                                                                                                                                                                                                                                                                                                                                                                                               |
| Write-1-to-clear    | Software must write a 1 to the bit in order to clear it. Writing a 0 to these bits has no affect.                                                                                                                                                                                                                                                                                             |
| Write-1-only        | Software can set the bit high by writing a 1 to it. Writes of 0 have no effect.                                                                                                                                                                                                                                                                                                               |
| Reset-applied       | Takes effect on warm reset.                                                                                                                                                                                                                                                                                                                                                                   |
| GP-read             | GP exception occurs on read.                                                                                                                                                                                                                                                                                                                                                                  |
| GP-write            | GP exception occurs on write.                                                                                                                                                                                                                                                                                                                                                                 |
| GP-read-write       | GP exception occurs on a read or a write.                                                                                                                                                                                                                                                                                                                                                     |
| Per-core            | One instance per core. Only valid for MMIO config space. Writes of these bits from one core only affect that core’s register. Reads return the values appropriate to that core.                                                                                                                                                                                                               |
| Per-compute-unit    | One instance per compute unit. Writes of these bits from one core only affect that compute unit’s register. Reads return the values appropriate to that compute unit. See <a href="#">2.4.2.1 [Registers Shared by Cores in a Compute Unit]</a> .                                                                                                                                             |
| SharedNC            | All cores share the one instance per-compute-unit non-coherently; see <a href="#">2.4.2.1 [Reg-isters Shared by Cores in a Compute Unit]</a> . Valid only with per-compute-unit.                                                                                                                                                                                                              |

**Table 60: Terminology in Register Descriptions**

| Term              | Definition                                                                                                                                                                                                                                                                                                                                                                                               |
|-------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Per-L2            | One instance per L2 cache. See <a href="#">CUID Fn8000_001D_EAX_x2</a> [NumSharingCache].                                                                                                                                                                                                                                                                                                                |
| Per-node          | One instance per node. See <a href="#">3.1.1 [Northbridge MSRs In Multi-Core Products]</a> .                                                                                                                                                                                                                                                                                                             |
| Not-same-for-all  | Provide indication as to whether all instances of a given register should be the same across all cores/nodes according to the following equation:<br>SameOnAllCheckEnabled = (Writable && (same-for-all   MSR) && ~(not-same-for-all    UpdatedByHw)). UpdatedByHw = (Updated-by-hardware    set-by-hardware    cleared-by-hardware    set-when-done    cleared-when-done).                              |
| Same-for-all      |                                                                                                                                                                                                                                                                                                                                                                                                          |
| Field Definitions |                                                                                                                                                                                                                                                                                                                                                                                                          |
| Reserved          | Field is reserved for future use. Software is required to preserve the state read from these bits when writing to the register. Software may not depend on the state of reserved fields nor on the ability of such fields to return the state previously written.                                                                                                                                        |
| Unused            | Field is reserved for future use. Software is not required to preserve the state read from these bits when writing to the register. Software may not depend on the state of unused fields nor on the ability of such fields to return the state previously written.                                                                                                                                      |
| MBZ               | Must be zero. If software attempts to set an MBZ bit to 1, a general-protection exception (#GP) occurs.                                                                                                                                                                                                                                                                                                  |
| RAZ               | Read as zero. Writes are ignored, unless RAZ is combined with write-only or write-1-only.                                                                                                                                                                                                                                                                                                                |
| Reset Definitions |                                                                                                                                                                                                                                                                                                                                                                                                          |
| Reset             | The reset value of each register is provided below the mnemonic or in the field description. Unless otherwise noted, the register state matches the reset value when RESET_L is asserted (either a cold or a warm reset). Reset values may include: <ul style="list-style-type: none"><li>• X: an X in the reset value indicates that the field resets (warm or cold) to an unspecified state.</li></ul> |
| Cold reset        | The field state is not affected by a warm reset (even if the field is labeled “cold reset: X”); it is placed into the reset state when PWROK is deasserted. See "Reset" above for the definition of characters that may be found in the cold reset value.                                                                                                                                                |
| Value             | The current value of a read-only field or register. A value statement explicitly defines the field or register as read-only and the value returned under all conditions including after reset events. A field labeled “Value:” will not have a separate reset definition.                                                                                                                                |

### 3.1.1 Northbridge MSRs In Multi-Core Products

MSRs that control Northbridge functions are shared between all cores on the node in a multi-core processor (e.g. [MSRC001\\_001F](#)). If control of Northbridge functions is shared between software on all cores, software must ensure that only one core at a time is allowed to access the shared MSR. Some MSR's are conditionally shared; see [D18F3x44](#)[NbMcaToMstCpuEn].

### 3.1.2 Software Recommendation (BIOS, SBIOS)

The following keywords specify the recommended value to be set by software.

- BIOS: AMD BIOS.
- SBIOS: Platform BIOS.



Syntax: BIOS: integer-expression. Any of the supported tags can be substituted for BIOS.

If “BIOS:” occurs in a register field then the recommended value is applied to the field. If “BIOS:” occurs after a register name but outside of a register field table row then the recommended value is applied to the width of the register.

### 3.1.3 See Keyword (See:)

There is a special meaning applied to the use of “See:” that differs from the use of See not followed by a “:”.

- See, not followed by a “:”, simply refers the reader to a document location that contains related information.
- See followed by a “:” is a shorthand notation that indicates that the definition for this register or register field inherits all properties and definitions from the register or register field that follows “See:”. Any definition local to the register or register field supercedes this inheritance.

“See:” can be used in the following ways:

- Full register width. [CPUID Fn0000\\_0001\\_EAX](#) inherits its full register width definition from [D18F3xFC](#).
- Register field. [MSR0000\\_0277\[PA1MemType\]](#) inherits its definition from PA0MemType, however, the local reset of 4h overrides the inherited PA0MemType reset of 6h.
- Valid values definition. [MSR0000\\_020\[E,C,A,8,6,4,2,0\]\[MemType\]](#), for example, inherits the valid values definition from [Table 216 \[Valid Values for Memory Type Definition\]](#).

### 3.1.4 Mapping Tables

The following mapping table types are defined.

#### 3.1.4.1 Register Mapping

The register mapping table specifies the specific function for each register in a range of registers.

[Table 188](#), for example, specifies that the D18F5x160 function is for NB P-state 0.

#### 3.1.4.2 Index Mapping

The index mapping table is similar to the register mapping table, but specifies the register by index instead of by full register mnemonic.

#### 3.1.4.3 Field Mapping

The field mapping table maps the fields of a range of registers. The rows are the registers that are mapped. Each column specifies a field bit range that is mapped by that column for all registers. The cell at the intersection of the register and the field bit range specifies the suffix that is appended to the register field. “Reserved” specifies that the field is reserved for the register of that row.

#### 3.1.4.4 Broadcast Mapping

The broadcast mapping table maps a register address to a range of register addresses that are written as a group when the broadcast register address is written. The register address is formed by the concatenation of the row address with the column address. The cell at the intersection of the row and column address is a range of register addresses that will be written as a group when the row and column address is written.



### 3.1.4.5 Reset Mapping

The reset mapping table specifies the reset, cold reset, or value for each register in a range of registers.

Table 211 [Reset Mapping for CPUID Fn8000\_0000\_E[D,C,B]X], for example, specifies that the CPUID Fn0000\_0000\_EBX register has a value of 6874\_7541h, with a comment of “The ASCII characters “h t u A””.

### 3.1.4.6 Valid Values

The valid values table defines the valid values for one or more register fields. The valid values table is equivalent in function to the Bits/Description tables in register fields (E.g. MSR0000\_0277[PA0MemType]) and is most often used when the table becomes too large and unwieldy to be included into the register field. (E.g. Table 216 [Valid Values for Memory Type Definition])

### 3.1.4.7 BIOS Recommendations

The BIOS recommendations table defines “BIOS:” recommendations that are conditional and complex enough to warrant a table.

Table 180 [BIOS Recommendations for D18F2x1B[4:0]], for example, specifies the BIOS recommendations for D18F2x1B0[DcqBwThrotWm] and D18F2x1B4[DcqBwThrotWm1, DcqBwThrotWm2]. All cells under the “Condition” header for a given row are ANDed to form the condition for the values to the right of the condition. For example, rows 1-3 and column 1 provide the following equivalent BIOS recommendation:

- D18F2x1B0[DcqBwThrotWm]: BIOS: IF (DdrRate==667) THEN 4h ELSEIF (DdrRate==800) THEN 5h ELSEIF (DdrRate==1066) THEN 6h ELSEIF etc.

## 3.2 IO Space Registers

See 3.1 [Register Descriptions and Mnemonics] for a description of the register naming convention.

### IOCF8 IO-Space Configuration Address

Reset: 0. IOCF8 [IO-Space Configuration Address], and IOCFC [IO-Space Configuration Data Port], are used to access system configuration space, as defined by the PCI specification. IOCF8 provides the address register and IOCFC provides the data port. Software sets up the configuration address by writing to IOCF8. Then, when an access is made to IOCFC, the processor generates the corresponding configuration access to the address specified in IOCF8. See 2.7 [Configuration Space].

IOCF8 may only be accessed through aligned, DW IO reads and writes; otherwise, the accesses are passed to the appropriate IO link. Accesses to IOCF8 and IOCFC received from an IO link are treated as all other IO transactions received from an IO link and are forwarded based on the settings in D18F1x[DC:C0] [IO-Space Base/Limit]. IOCF8 and IOCFC in the processor are not accessible from an IO link.

| Bits  | Description                                                                                                                                                                                                                                                                                                   |
|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31    | <b>ConfigEn: configuration space enable.</b> Read-write. 1=IO read and write accesses to IOCFC are translated into configuration cycles at the configuration address specified by this register. 0=IO read and write accesses are passed to the appropriate IO link and no configuration access is generated. |
| 30:28 | Reserved.                                                                                                                                                                                                                                                                                                     |
| 27:24 | <b>ExtRegNo: extended register number.</b> Read-write. ExtRegNo provides bits[11:8] and RegNo provides bits[7:2] of the byte address of the configuration register. ExtRegNo is reserved unless it is enabled by MSRC001_001F[EnableCf8ExtCfg].                                                               |

|       |                                                                                                |
|-------|------------------------------------------------------------------------------------------------|
| 23:16 | <b>BusNo: bus number.</b> Read-write. Specifies the bus number of the configuration cycle.     |
| 15:11 | <b>Device: bus number.</b> Read-write. Specifies the device number of the configuration cycle. |
| 10:8  | <b>Function.</b> Read-write. Specifies the function number of the configuration cycle.         |
| 7:2   | <b>RegNo: register address.</b> Read-write. See <a href="#">IOCF8</a> [ExtRegNo].              |
| 1:0   | Reserved.                                                                                      |

#### **IOCF8 IO-Space Configuration Data Port**

---

| Bits | Description                                                    |
|------|----------------------------------------------------------------|
| 31:0 | <b>Data.</b> Read-write. Reset: 0. See <a href="#">IOCF8</a> . |

### 3.3 Device 0 Function 0 (Root Complex) Configuration Registers

See 3.1 [Register Descriptions and Mnemonics] for a description of the register naming convention. See 2.7 [Configuration Space] for details about how to access this space.

#### D0F0x00 Device/Vendor ID

| Bits  | Description                                          |
|-------|------------------------------------------------------|
| 31:16 | <b>DeviceID: device ID.</b> Read-only. Value: 1422h. |
| 15:0  | <b>VendorID: vendor ID.</b> Read-only. Value: 1022h. |

#### D0F0x04 Status/Command

Reset: 0000\_0004h.

| Bits  | Description                                                              |
|-------|--------------------------------------------------------------------------|
| 31:21 | Reserved.                                                                |
| 20    | <b>CapList: capability list.</b> Read-only. 1=Capability list supported. |
| 19:3  | Reserved.                                                                |
| 2     | <b>BusMasterEn: bus master enable.</b> Read-only.                        |
| 1     | <b>MemAccessEn: memory access enable.</b> Read-only.                     |
| 0     | <b>IoAccessEn: IO access enable.</b> Read-only.                          |

#### D0F0x08 Class Code/Revision ID

Reset: 0600\_0000h.

| Bits | Description                                                                                                       |
|------|-------------------------------------------------------------------------------------------------------------------|
| 31:8 | <b>ClassCode: class code.</b> Read-only. Provides the host bridge class code as defined in the PCI specification. |
| 7:0  | <b>RevID: revision ID.</b> Read-only.                                                                             |

#### D0F0x0C Header Type

Reset: 0080\_0000h.

| Bits  | Description                                                                        |
|-------|------------------------------------------------------------------------------------|
| 31:24 | Reserved.                                                                          |
| 23    | <b>DeviceType.</b> Read-only. 0b=Single function device. 1b=Multi-function device. |
| 22:16 | <b>HeaderType.</b> Read-only.                                                      |
| 15:8  | <b>LatencyTimer.</b> Read-only.                                                    |
| 7:0   | <b>CacheLineSize.</b> Read-only.                                                   |

**D0F0x2C Subsystem and Subvendor ID**

| Bits  | Description                                         |
|-------|-----------------------------------------------------|
| 31:16 | <b>SubsystemID</b> . Read-only. Value: 1410h.       |
| 15:0  | <b>SubsystemVendorID</b> . Read-only. Value: 1022h. |

**D0F0x34 Capabilities Pointer**

Reset: 0000\_0000h.

| Bits | Description                                                                   |
|------|-------------------------------------------------------------------------------|
| 31:8 | Reserved.                                                                     |
| 7:0  | <b>CapPtr: capabilities pointer</b> . Read-only. There is no capability list. |

**D0F0x48 NB Header Write Register**

Reset: 0000\_0080h.

| Bits | Description                                                                                                                                                                                     |
|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:8 | Reserved.                                                                                                                                                                                       |
| 7    | <b>DeviceType: device type</b> . Read-write. This field sets the value in the corresponding field in <a href="#">D0F0x0C[DeviceType]</a> . 0b=Single function device. 1b=Multi-function device. |
| 6:0  | Reserved.                                                                                                                                                                                       |

**D0F0x4C PCI Control**

Reset: 0000\_0000h.

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:27 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 26    | <b>HPDis: hot plug message disable</b> . Read-write. 1=Hot plug message generation is disabled.                                                                                                                                                                                                                                                                                                                                                              |
| 25:24 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 23    | <b>MMIOEnable: memory mapped IO enable</b> . Read-write. 1=Decoding of MMIO cycles is enabled. The MMIO Base/Limit pair ( <a href="#">D0F0x64_x17</a> and <a href="#">D0F0x64_x18</a> ) are decoded. This range is used to create an MMIO hole in the DRAM address range used for DMA decoding. DMA writes that fall into the MMIO range are treated as potential p2p requests. DMA reads that fall into the MMIO range are aborted as unsupported requests. |
| 22:15 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 14:6  | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 5     | <b>SerrDis: system error message disable</b> . Read-write. 1=The generation of SERR messages is disabled.                                                                                                                                                                                                                                                                                                                                                    |
| 4     | <b>PMEDis: PME disable</b> . Read-write. 1=The generation of PME messages is disabled.                                                                                                                                                                                                                                                                                                                                                                       |
| 3:0   | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                    |

**D0F0x60 Miscellaneous Index**

Reset: 0000\_0000h. The index/data pair registers, [D0F0x60](#) and [D0F0x64](#), are used to access the registers at [D0F0x64\\_x\[FF:00\]](#). To access any of these registers, the address is first written into the index register, [D0F0x60](#), and then the data is read from or written to the data register, [D0F0x64](#).

| Bits | Description                                                           |
|------|-----------------------------------------------------------------------|
| 31:7 | Reserved.                                                             |
| 6:0  | <b>MiscIndAddr:</b> miscellaneous index register address. Read-write. |

**D0F0x64 Miscellaneous Index Data**

See [D0F0x60](#). Address: [D0F0x60](#)[MiscIndAddr].

| Bits | Description                                            |
|------|--------------------------------------------------------|
| 31:0 | <b>MiscIndData:</b> miscellaneous index data register. |

**D0F0x64\_x00 Northbridge Control**

Reset: 0000\_0000h.

| Bits | Description                                                                          |
|------|--------------------------------------------------------------------------------------|
| 31:8 | Reserved.                                                                            |
| 7    | <b>HwInitWrLock.</b> Read-write. 1=Lock HWInit registers. 0=Unlock HWInit registers. |
| 6:0  | Reserved.                                                                            |

**D0F0x64\_x0C IOC Bridge Control**

Reset: 0000\_0000h.

| Bits | Description |
|------|-------------|
| 31:0 | Reserved.   |

**D0F0x64\_x0D IOC PCI Configuration**

| Bits | Description                                                                                           |
|------|-------------------------------------------------------------------------------------------------------|
| 31   | <b>IommuDis.</b> Read-only. Value: Product specific.                                                  |
| 30:1 | Reserved.                                                                                             |
| 0    | <b>PciDev0Fn2RegEn.</b> Read-write. Reset: 1. 1=Enable configuration accesses to device 0 function 2. |

**D0F0x64\_x16 IOC Advanced Error Reporting Control**

Reset: 0000\_0001h.

| Bits | Description                                                                                                                     |
|------|---------------------------------------------------------------------------------------------------------------------------------|
| 31:1 | Reserved.                                                                                                                       |
| 0    | <b>AerUrMsgEn: AER unsupported request message enable.</b> Read-write. BIOS: 0. 1=AER unsupported request messages are enabled. |

**D0F0x64\_x17 Memory Mapped IO Base Address**

Reset: 0000\_0000h.

| Bits | Description                                                        |
|------|--------------------------------------------------------------------|
| 31:0 | <b>MmioBase[47:16]: memory mapped IO base address.</b> Read-write. |

**D0F0x64\_x18 Memory Mapped IO Limit**

Reset: 0000\_0000h.

| Bits | Description                                                  |
|------|--------------------------------------------------------------|
| 31:0 | <b>MmioLimit[47:16]: memory mapped IO limit.</b> Read-write. |

**D0F0x64\_x19 Top of Memory 2 Low**

Reset: 0000\_0000h.

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:23 | <b>Tom2[31:23]: top of memory 2.</b> Read-write. BIOS: <a href="#">MSRC001_001D</a> [TOM2[31:23]]. This field specifies the maximum system address for upstream read and write transactions that are forwarded to the host bridge. All addresses less than this system address are forwarded to DRAM and are not checked to determine if the transaction is a peer-to-peer transaction. All upstream reads with addresses greater than or equal to this system address are master aborted. |
| 22:1  | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 0     | <b>TomEn: top of memory enable.</b> Read-write. BIOS: <a href="#">MSRC001_0010</a> [MtrrTom2En]. 1=Top of memory check enabled.                                                                                                                                                                                                                                                                                                                                                            |

**D0F0x64\_x1A Top of Memory 2 High**

Reset: 0000\_0000h.

| Bits | Description                                                                                                                                |
|------|--------------------------------------------------------------------------------------------------------------------------------------------|
| 31:8 | Reserved.                                                                                                                                  |
| 7:0  | <b>Tom2[39:32]: top of memory 2.</b> Read-write. BIOS: <a href="#">MSRC001_001D</a> [TOM2[39:32]]. See <a href="#">D0F0x64_x19</a> [Tom2]. |

**D0F0x64\_x1D Internal Graphics PCI Control**

Reset: 0000\_0000h.

| Bits | Description                                                                                                                                                                                                   |
|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:4 | Reserved.                                                                                                                                                                                                     |
| 3    | <b>Vga16En: VGA IO 16 bit decoding enable.</b> Read-write. BIOS: <a href="#">D0F0x64_x1D[VgaEn]</a> . 1=Address bits 15:10 for VGA IO cycles are decoded. 0=Address bits 15:10 for VGA IO cycles are ignored. |
| 2    | Reserved.                                                                                                                                                                                                     |
| 1    | <b>VgaEn: VGA enable.</b> Read-write. 1=Enable VGA range in Intgfx.                                                                                                                                           |
| 0    | Reserved.                                                                                                                                                                                                     |

**D0F0x64\_x1F FCH Location**

Reset: 0004\_0001h.

| Bits        | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |      |            |       |                  |       |                                         |       |                                         |       |           |       |                                         |             |           |       |                                         |             |           |       |                                         |             |           |
|-------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------------|-------|------------------|-------|-----------------------------------------|-------|-----------------------------------------|-------|-----------|-------|-----------------------------------------|-------------|-----------|-------|-----------------------------------------|-------------|-----------|-------|-----------------------------------------|-------------|-----------|
| 31:16       | <b>SBLocatedCore: Indicates which GPP Core has the FCH attached to it.</b> Read-write.<br><table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>0000h</td><td>No FCH attached.</td></tr> <tr> <td>0001h</td><td>FCH located under PGD.</td></tr> <tr> <td>0002h</td><td>FCH located under PPD.</td></tr> <tr> <td>0003h</td><td>Reserved.</td></tr> <tr> <td>0004h</td><td>FCH located under PSD.</td></tr> <tr> <td>FFFFh-0005h</td><td>Reserved.</td></tr> </table>                                                                                                                                                                                                                                                                                                          | Bits | Definition | 0000h | No FCH attached. | 0001h | FCH located under PGD.                  | 0002h | FCH located under PPD.                  | 0003h | Reserved. | 0004h | FCH located under PSD.                  | FFFFh-0005h | Reserved. |       |                                         |             |           |       |                                         |             |           |
| Bits        | Definition                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |      |            |       |                  |       |                                         |       |                                         |       |           |       |                                         |             |           |       |                                         |             |           |       |                                         |             |           |
| 0000h       | No FCH attached.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |      |            |       |                  |       |                                         |       |                                         |       |           |       |                                         |             |           |       |                                         |             |           |       |                                         |             |           |
| 0001h       | FCH located under PGD.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |      |            |       |                  |       |                                         |       |                                         |       |           |       |                                         |             |           |       |                                         |             |           |       |                                         |             |           |
| 0002h       | FCH located under PPD.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |      |            |       |                  |       |                                         |       |                                         |       |           |       |                                         |             |           |       |                                         |             |           |       |                                         |             |           |
| 0003h       | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |      |            |       |                  |       |                                         |       |                                         |       |           |       |                                         |             |           |       |                                         |             |           |       |                                         |             |           |
| 0004h       | FCH located under PSD.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |      |            |       |                  |       |                                         |       |                                         |       |           |       |                                         |             |           |       |                                         |             |           |       |                                         |             |           |
| FFFFh-0005h | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |      |            |       |                  |       |                                         |       |                                         |       |           |       |                                         |             |           |       |                                         |             |           |       |                                         |             |           |
| 15:0        | <b>SBLocatedPort: Indicates which Port on the SBLocatedCore has the FCH.</b> Read-write.<br><table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>0000h</td><td>No FCH attached.</td></tr> <tr> <td>0001h</td><td>FCH located on Port A of SBLocatedCore.</td></tr> <tr> <td>0002h</td><td>FCH located on Port B of SBLocatedCore.</td></tr> <tr> <td>0003h</td><td>Reserved.</td></tr> <tr> <td>0004h</td><td>FCH located on Port C of SBLocatedCore.</td></tr> <tr> <td>0007h-0005h</td><td>Reserved.</td></tr> <tr> <td>0008h</td><td>FCH located on Port D of SBLocatedCore.</td></tr> <tr> <td>000Fh-0009h</td><td>Reserved.</td></tr> <tr> <td>0010h</td><td>FCH located on Port E of SBLocatedCore.</td></tr> <tr> <td>FFFFh-0011h</td><td>Reserved.</td></tr> </table> | Bits | Definition | 0000h | No FCH attached. | 0001h | FCH located on Port A of SBLocatedCore. | 0002h | FCH located on Port B of SBLocatedCore. | 0003h | Reserved. | 0004h | FCH located on Port C of SBLocatedCore. | 0007h-0005h | Reserved. | 0008h | FCH located on Port D of SBLocatedCore. | 000Fh-0009h | Reserved. | 0010h | FCH located on Port E of SBLocatedCore. | FFFFh-0011h | Reserved. |
| Bits        | Definition                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |      |            |       |                  |       |                                         |       |                                         |       |           |       |                                         |             |           |       |                                         |             |           |       |                                         |             |           |
| 0000h       | No FCH attached.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |      |            |       |                  |       |                                         |       |                                         |       |           |       |                                         |             |           |       |                                         |             |           |       |                                         |             |           |
| 0001h       | FCH located on Port A of SBLocatedCore.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |      |            |       |                  |       |                                         |       |                                         |       |           |       |                                         |             |           |       |                                         |             |           |       |                                         |             |           |
| 0002h       | FCH located on Port B of SBLocatedCore.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |      |            |       |                  |       |                                         |       |                                         |       |           |       |                                         |             |           |       |                                         |             |           |       |                                         |             |           |
| 0003h       | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |      |            |       |                  |       |                                         |       |                                         |       |           |       |                                         |             |           |       |                                         |             |           |       |                                         |             |           |
| 0004h       | FCH located on Port C of SBLocatedCore.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |      |            |       |                  |       |                                         |       |                                         |       |           |       |                                         |             |           |       |                                         |             |           |       |                                         |             |           |
| 0007h-0005h | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |      |            |       |                  |       |                                         |       |                                         |       |           |       |                                         |             |           |       |                                         |             |           |       |                                         |             |           |
| 0008h       | FCH located on Port D of SBLocatedCore.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |      |            |       |                  |       |                                         |       |                                         |       |           |       |                                         |             |           |       |                                         |             |           |       |                                         |             |           |
| 000Fh-0009h | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |      |            |       |                  |       |                                         |       |                                         |       |           |       |                                         |             |           |       |                                         |             |           |       |                                         |             |           |
| 0010h       | FCH located on Port E of SBLocatedCore.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |      |            |       |                  |       |                                         |       |                                         |       |           |       |                                         |             |           |       |                                         |             |           |       |                                         |             |           |
| FFFFh-0011h | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |      |            |       |                  |       |                                         |       |                                         |       |           |       |                                         |             |           |       |                                         |             |           |       |                                         |             |           |

**D0F0x64\_x22 LCLK Control 0**

Reset: 7F3F\_8100h.

| Bits | Description                                                                                                                |
|------|----------------------------------------------------------------------------------------------------------------------------|
| 31   | Reserved.                                                                                                                  |
| 30   | <b>SoftOverrideClk0.</b> Read-write. BIOS: 0. 1=Dynamic clock gating disabled for the host request path to the PCIe cores. |

|      |                                                                                                                                                              |
|------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 29   | <b>SoftOverrideClk1.</b> Read-write. BIOS: 0. 1=Dynamic clock gating disabled for the host request path to the internal graphics and the host response path. |
| 28   | <b>SoftOverrideClk2.</b> Read-write. BIOS: 0. 1=Dynamic clock gating disabled for the host configuration requests.                                           |
| 27   | <b>SoftOverrideClk3.</b> Read-write. BIOS: 0. 1=Dynamic clock gating disabled for the debug bus path.                                                        |
| 26   | <b>SoftOverrideClk4.</b> Read-write. BIOS: 0. 1=Dynamic clock gating disabled for the host request path to the configuration block.                          |
| 25:0 | Reserved.                                                                                                                                                    |

### D0F0x64\_x23 LCLK Control 1

Reset: 7F3F\_8100h.

| Bits | Description                                                                                                                                                          |
|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31   | Reserved.                                                                                                                                                            |
| 30   | <b>SoftOverrideClk0.</b> Read-write. BIOS: 0. 1=Dynamic clock gating disabled for upstream DMA requests from all sources.                                            |
| 29   | <b>SoftOverrideClk1.</b> Read-write. BIOS: 0. 1=Dynamic clock gating disabled for upstream DMA requests from the GPPFCH link core.                                   |
| 28   | <b>SoftOverrideClk2.</b> Read-write. BIOS: 0. 1=Dynamic clock gating disabled for upstream DMA requests from internal graphics and its DMA response reordering path. |
| 27   | <b>SoftOverrideClk3.</b> Read-write. BIOS: 0. 1=Dynamic clock gating disabled for upstream DMA requests from internal graphics.                                      |
| 26   | <b>SoftOverrideClk4.</b> Read-write. BIOS: 0. 1=Dynamic clock gating disabled for upstream DMA requests from the Gfx link core.                                      |
| 25:0 | Reserved.                                                                                                                                                            |

### D0F0x64\_x3[B:0] Programmable Device Remap Register

Table 61: Reset values for D0F0x64\_x3[B:0]

| Register    | Reset      | Function                                                |
|-------------|------------|---------------------------------------------------------|
| D0F0x64_x30 | 0000_0011h | Program [7:3]DevNum, [2:0]FnNum to map to PortA of PGD. |
| D0F0x64_x31 | 0000_0012h | Program [7:3]DevNum, [2:0]FnNum to map to PortB of PGD. |
| D0F0x64_x32 | 0000_0019h | Program [7:3]DevNum, [2:0]FnNum to map to PortA of PPD. |
| D0F0x64_x33 | 0000_001Ah | Program [7:3]DevNum, [2:0]FnNum to map to PortB of PPD. |
| D0F0x64_x34 | 0000_001Bh | Program [7:3]DevNum, [2:0]FnNum to map to PortC of PPD. |
| D0F0x64_x35 | 0000_001Ch | Program [7:3]DevNum, [2:0]FnNum to map to PortD of PPD. |
| D0F0x64_x36 | 0000_001Dh | Program [7:3]DevNum, [2:0]FnNum to map to PortE of PPD. |
| D0F0x64_x37 | 0000_0021h | Program [7:3]DevNum, [2:0]FnNum to map to PortA of PSD. |
| D0F0x64_x38 | 0000_0022h | Program [7:3]DevNum, [2:0]FnNum to map to PortB of PSD. |
| D0F0x64_x39 | 0000_0023h | Program [7:3]DevNum, [2:0]FnNum to map to PortC of PSD. |
| D0F0x64_x3A | 0000_0024h | Program [7:3]DevNum, [2:0]FnNum to map to PortD of PSD. |
| D0F0x64_x3B | 0000_0025h | Program [7:3]DevNum, [2:0]FnNum to map to PortE of PSD. |

Software can only utilize device and function number combinations that are used by other (local) PCIe bridges.



This effectively allows swapping of device and function numbers between bridges.

| Bits | Description                                                                                           |
|------|-------------------------------------------------------------------------------------------------------|
| 31:8 | Reserved.                                                                                             |
| 7:0  | <b>DevFnMap.</b> Read-write. Program [7:3]DevNum, [2:0]FnNum to map to PortA/B/C/D of each PCIe core. |

### D0F0x64\_x46 IOC Features Control

Reset: 0000\_1063h.

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |      |            |     |                                                                                                                                                     |     |                                                                                                                                                                   |     |                                                 |     |           |
|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------------|-----|-----------------------------------------------------------------------------------------------------------------------------------------------------|-----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-------------------------------------------------|-----|-----------|
| 31:28 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |      |            |     |                                                                                                                                                     |     |                                                                                                                                                                   |     |                                                 |     |           |
| 27:24 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |      |            |     |                                                                                                                                                     |     |                                                                                                                                                                   |     |                                                 |     |           |
| 23    | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |      |            |     |                                                                                                                                                     |     |                                                                                                                                                                   |     |                                                 |     |           |
| 22    | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |      |            |     |                                                                                                                                                     |     |                                                                                                                                                                   |     |                                                 |     |           |
| 21:17 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |      |            |     |                                                                                                                                                     |     |                                                                                                                                                                   |     |                                                 |     |           |
| 16    | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |      |            |     |                                                                                                                                                     |     |                                                                                                                                                                   |     |                                                 |     |           |
| 15:5  | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |      |            |     |                                                                                                                                                     |     |                                                                                                                                                                   |     |                                                 |     |           |
| 4:3   | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |      |            |     |                                                                                                                                                     |     |                                                                                                                                                                   |     |                                                 |     |           |
| 2:1   | <b>P2PMode: peer-to-peer mode.</b> Read-write. Specifies how upstream write transactions above D0F0x64_x19[Tom2] are completed.<br><table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00b</td><td>Mode 0. Master abort writes that do not hit one of the internal PCI bridges. Forward writes that hit one of the internal PCI bridges to the bridge.</td></tr> <tr> <td>01b</td><td>Mode 1. Forward writes to the host bridge that do not hit one of the internal PCI bridges. Forward writes that hit one of the internal PCI bridges to the bridge.</td></tr> <tr> <td>10b</td><td>Mode 2. Forward all writes to the host bridge0.</td></tr> <tr> <td>11b</td><td>Reserved.</td></tr> </table> | Bits | Definition | 00b | Mode 0. Master abort writes that do not hit one of the internal PCI bridges. Forward writes that hit one of the internal PCI bridges to the bridge. | 01b | Mode 1. Forward writes to the host bridge that do not hit one of the internal PCI bridges. Forward writes that hit one of the internal PCI bridges to the bridge. | 10b | Mode 2. Forward all writes to the host bridge0. | 11b | Reserved. |
| Bits  | Definition                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |      |            |     |                                                                                                                                                     |     |                                                                                                                                                                   |     |                                                 |     |           |
| 00b   | Mode 0. Master abort writes that do not hit one of the internal PCI bridges. Forward writes that hit one of the internal PCI bridges to the bridge.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |      |            |     |                                                                                                                                                     |     |                                                                                                                                                                   |     |                                                 |     |           |
| 01b   | Mode 1. Forward writes to the host bridge that do not hit one of the internal PCI bridges. Forward writes that hit one of the internal PCI bridges to the bridge.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |      |            |     |                                                                                                                                                     |     |                                                                                                                                                                   |     |                                                 |     |           |
| 10b   | Mode 2. Forward all writes to the host bridge0.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |      |            |     |                                                                                                                                                     |     |                                                                                                                                                                   |     |                                                 |     |           |
| 11b   | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |      |            |     |                                                                                                                                                     |     |                                                                                                                                                                   |     |                                                 |     |           |
| 0     | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |      |            |     |                                                                                                                                                     |     |                                                                                                                                                                   |     |                                                 |     |           |

### D0F0x7C IOC Configuration Control

Cold reset: 0000\_0000h.

| Bits | Description                                                                                                                                    |
|------|------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:1 | Reserved.                                                                                                                                      |
| 0    | <b>ForceIntGfxDisable: internal graphics disable.</b> Read-write. Setting this bit disables the internal graphics and the HD Audio controller. |

**D0F0x84 Link Arbitration**

| Bits  | Description                                                                                                                                                                                                                                   |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:10 | Reserved.                                                                                                                                                                                                                                     |
| 9     | <b>PmeTurnOff: PME_Turn_Off message trigger.</b> Read-write. Reset: 0. 1=Trigger a PME_Turn_Off message to all downstream devices if PmeMode=1.                                                                                               |
| 8     | <b>PmeMode: PME message mode.</b> Read-write. Reset: 0. 1=PME_Turn_Off message is triggered by writing PmeTurnOff. 0=PME_Turn_Off message is triggered by a message from the FCH.                                                             |
| 7     | Reserved.                                                                                                                                                                                                                                     |
| 6:4   | Reserved.                                                                                                                                                                                                                                     |
| 3     | <b>VgaHole: vga memory hole.</b> Read-write. Reset: 1. This bit creates a hole in memory for the VGA memory range. 1=Requests hitting the VGA range are checked against PCI bridge memory ranges instead of being forwarded to system memory. |
| 2:0   | Reserved.                                                                                                                                                                                                                                     |

**D0F0x90 Northbridge Top of Memory**

Reset: 0000\_0000h.

| Bits  | Description                                                                                                                                                                                     |
|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:23 | <b>TopOfDram.</b> Read-write. BIOS: <a href="#">MSRC001_001A</a> [TOM[31:23]]. Specifies the address that divides between MMIO and DRAM. From TopOfDram to 4G is MMIO; below TopOfDram is DRAM. |
| 22:1  | Reserved.                                                                                                                                                                                       |
| 0     | Reserved.                                                                                                                                                                                       |

**D0F0x94 Northbridge ORB Configuration Offset**

Reset: 0000\_0000h.

The index/data pair registers, [D0F0x94](#) and [D0F0x98](#), are used to access the registers at [D0F0x98\\_x](#)[FF:00]. To access any of these registers, the address is first written into the index register, [D0F0x94](#), and then the data is read from or written to the data register, [D0F0x98](#).

| Bits | Description                                                |
|------|------------------------------------------------------------|
| 31:7 | Reserved.                                                  |
| 6:0  | <b>OrbIndAddr: ORB index register address.</b> Read-write. |

**D0F0x98 Northbridge ORB Configuration Data Port**

See [D0F0x94](#). Address: [D0F0x94](#)[OrbIndAddr].

| Bits | Description                                 |
|------|---------------------------------------------|
| 31:0 | <b>OrbIndData: ORB index data register.</b> |

**D0F0x98\_x02 ORB PGMEM Control**

Reset: 0000\_0000h.

| Bits  | Description                                                                                                                                                                                    |
|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:16 | <b>PgmemHysteresis</b> . Read-write. Hysteresis value for power-gating of ORB TX group of memories. Value represents absolute number of LCLK cycles.                                           |
| 15:8  | Reserved.                                                                                                                                                                                      |
| 7:5   | <b>TxPgmemStEn</b> . Read-write. Power-gating enablement for the ORB TX group of memories. Bits are mutually exclusive. 7=SD (shutdown) mode. 6=DS (deep sleep) mode. 5=LS (light sleep) mode. |
| 4:2   | <b>RxPgmemStEn</b> . Read-write. Power-gating enablement for the ORB RX group of memories. Bits are mutually exclusive. 4=SD (shutdown) mode. 3=DS (deep sleep) mode. 2=LS (light sleep) mode. |
| 1     | <b>OrbTxPgmemEn</b> . Read-write. Enables ORB TX memory power-gating.                                                                                                                          |
| 0     | <b>OrbRxPgmemEn</b> . Read-write. Enables ORB RX memory power-gating.                                                                                                                          |

**D0F0x98\_x06 ORB Downstream Control 0**

Reset: 0000\_0000h.

| Bits  | Description                                                                                                                                                                   |
|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:27 | Reserved.                                                                                                                                                                     |
| 26    | <b>UmiNpMemWrEn</b> . Read-write. BIOS: See 2.11.4. 1=NP protocol over UMI for memory-mapped writes targeting LPC enabled. This bit may be set to avoid a deadlock condition. |
| 25:0  | Reserved.                                                                                                                                                                     |

**D0F0x98\_x07 ORB Upstream Arbitration Control 0**

Reset: 0000\_0080h.

| Bits  | Description                                                                                                                                                                                                                                                                    |     |             |   |           |   |                        |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-------------|---|-----------|---|------------------------|
| 31    | <b>SMUCsrIsocEn</b> . Read-write. BIOS: 1. 1=CSR accesses go through ISOC channel. If this bit is set, <a href="#">D0F0x98_x1E[HiPriEn]</a> must also be set.                                                                                                                  |     |             |   |           |   |                        |
| 30:17 | Reserved.                                                                                                                                                                                                                                                                      |     |             |   |           |   |                        |
| 16    | <b>SyncFloodOnParityErr</b> . Read-write. Enable short circuit syncflood when arb_np detects a parity error for error containment.                                                                                                                                             |     |             |   |           |   |                        |
| 15    | <b>DropZeroMaskWrEn</b> . Read-write. BIOS: 1. 1=Drop byte write request that have all bytes masked. 0=Forward byte write request that have all bytes masked.                                                                                                                  |     |             |   |           |   |                        |
| 14:8  | Reserved.                                                                                                                                                                                                                                                                      |     |             |   |           |   |                        |
| 7     | <b>IommuIsocPassPWMode</b> . Read-write. BIOS: 1. 1=Always set PassPW for IOMMU upstream isochronous requests.                                                                                                                                                                 |     |             |   |           |   |                        |
| 6     | <b>DmaReqRespPassPWMode</b> . Read-write. BIOS: 0. Specifies the RespPassPW bit for non-posted upstreamDMA requests.<br><table> <tr> <th>Bit</th><th>Description</th></tr> <tr> <td>0</td><td>Always 1.</td></tr> <tr> <td>1</td><td>Value passed from IOC.</td></tr> </table> | Bit | Description | 0 | Always 1. | 1 | Value passed from IOC. |
| Bit   | Description                                                                                                                                                                                                                                                                    |     |             |   |           |   |                        |
| 0     | Always 1.                                                                                                                                                                                                                                                                      |     |             |   |           |   |                        |
| 1     | Value passed from IOC.                                                                                                                                                                                                                                                         |     |             |   |           |   |                        |

|   |                                                                                                                                                           |
|---|-----------------------------------------------------------------------------------------------------------------------------------------------------------|
| 5 | Reserved.                                                                                                                                                 |
| 4 | <b>IommuBwOptEn</b> . Read-write. BIOS: 1. 1=Optimize IOMMU L2 byte write by detecting consecutive DW mask and translate the request to DW write.         |
| 3 | Reserved.                                                                                                                                                 |
| 2 | <b>IocRdROMapDis</b> . Read-write. 1=Disable mapping relax ordering bit to RdRespPpw bit for IOC reads.                                                   |
| 1 | <b>IocWrROMapDis</b> . Read-write. 1=Disables mapping relax ordering bit to PassPw bit for IOC writes.                                                    |
| 0 | <b>IocBwOptEn</b> . Read-write. BIOS: 1. 1=Enable optimization of byte writes by detecting consecutive DW masks and translating the request to DW writes. |

#### D0F0x98\_x08 ORB Upstream Arbitration Control 1

This register specifies the weights of the weighted round-robin arbiter in stage 1 of the upstream arbitration for non-posted reads.

| Bits  | Description                                                                                                                                                                                          |
|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:24 | Reserved.                                                                                                                                                                                            |
| 23:16 | <b>NpWrrLenC</b> . Read-write. Reset: 8h. BIOS: 1h. This field defines the maximum number of non-posted read requests from the SMU that are serviced before the arbiter switches to the next client. |
| 15:8  | <b>NpWrrLenB</b> . Read-write. Reset: 8h. BIOS: 8h. This field defines the maximum number of non-posted read requests from IOMMU that are serviced before the arbiter switches to the next client.   |
| 7:0   | <b>NpWrrLenA</b> . Read-write. Reset: 8h. BIOS: 8h. This field defines the maximum number of non-posted read requests from IOC that are serviced before the arbiter switches to the next client.     |

#### D0F0x98\_x09 ORB Upstream Arbitration Control 2

Reset: 0000\_0808h.

This register specifies the weights of the weighted round-robin arbiter in stage 1 of the upstream arbitration for posted writes.

| Bits  | Description                                                                                                                                                                   |
|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:16 | Reserved.                                                                                                                                                                     |
| 15:8  | <b>PWrrLenB</b> . Read-write. This field defines the maximum number of posted write requests from the IOMMU that are serviced before the arbiter switches to the next client. |
| 7:0   | <b>PWrrLenA</b> . Read-write. This field defines the maximum number of posted write requests from the IOC that are serviced before the arbiter switches to the next client.   |

#### D0F0x98\_x0C ORB Upstream Arbitration Control 5

Reset: 0000\_0808h. This register specifies the weights of the weighted round-robin arbiter in stage 2 of the upstream arbitration.

| Bits  | Description                                                                                                                                                                                                                       |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:24 | Reserved.                                                                                                                                                                                                                         |
| 23:16 | Reserved.                                                                                                                                                                                                                         |
| 15:8  | <b>GcmWrrLenB</b> . Read-write. BIOS: 08h.<br>This field defines the maximum number of non-posted read requests from stage 1 that are getting serviced in the round-robin before the stage 2 arbiter switches to the next client. |
| 7:0   | <b>GcmWrrLenA</b> . Read-write. BIOS: 08h.<br>This field defines the maximum number of posted write requests from stage 1 that are getting serviced in the round-robin before the stage 2 arbiter switches to the next client.    |

### **D0F0x98\_x1E ORB Receive Control 0**

Reset: 4800\_0000h.

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                           |
|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:24 | <b>RxErrStatusDelay</b> . Read-write. BIOS: 48h. Delay error status by number of LCLK cycles to filter false errors caused by reset skew.                                                                                                                                                                                                                                                             |
| 23:2  | Reserved.                                                                                                                                                                                                                                                                                                                                                                                             |
| 1     | <b>HiPriEn</b> . Read-write. BIOS: 1. 1=High priority channel enabled. See <a href="#">D0F0x98_x27[IOMMUUrAddr[31:6]]</a> . IF ( <a href="#">D0F0x98_x1E[HiPriEn]</a> ==0) THEN ( <a href="#">D0F0x98_x07[SMUCsrIsocEn]</a> ==0). IF ( <a href="#">D0F0x98_x1E[HiPriEn]</a> ==1) THEN ( <a href="#">D18F0x[E4,C4,A4,84][IsocEn]</a> ==1) in order to fully enable the Isoc channel on the ONION Link. |
| 0     | Reserved.                                                                                                                                                                                                                                                                                                                                                                                             |

### **D0F0x98\_x26 ORB IOMMU Control 0**

Reset: 0000\_0000h.

| Bits | Description                                                                                   |
|------|-----------------------------------------------------------------------------------------------|
| 31:8 | Reserved.                                                                                     |
| 7:0  | <b>IOMMUUrAddr[39:32]</b> . Read-write. See: <a href="#">D0F0x98_x27[IOMMUUrAddr[31:6]]</a> . |

### **D0F0x98\_x27 ORB IOMMU Control 1**

Reset: 0000\_0000h.

| Bits | Description                                                                                                                                                                                                                                                                                                                                       |
|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:6 | <b>IOMMUUrAddr[31:6]</b> . Read-write. BIOS: IOMMUUrAddr[39:6] must be programmed to a safe system memory address when <a href="#">D0F2x44[IommuEnable]</a> =1 . IOMMUUrAddr[39:6] = { <a href="#">D0F0x98_x26[IOMMUUrAddr[39:32]]</a> , IOMMUUrAddr[31:6]}. IOMMU requests that are not directed to system memory are redirected to IOMMUUrAddr. |
| 5:0  | Reserved.                                                                                                                                                                                                                                                                                                                                         |

**D0F0x98\_x28 ORB Transmit Control 0**

Reset: 0000\_0002h.

| Bits | Description                                                                                             |
|------|---------------------------------------------------------------------------------------------------------|
| 31:2 | Reserved.                                                                                               |
| 1    | <b>ForceCoherentIntr.</b> Read-write. BIOS: 1. 1=Interrupt request are forced to have coherent bit set. |
| 0    | Reserved.                                                                                               |

**D0F0x98\_x2C ORB Clock Control**

Reset: 000F\_0200h.

| Bits  | Description                                                                                                                                                                                                                                                         |
|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:16 | <b>WakeHysteresis.</b> Read-write. BIOS: 19h. Specifies the amount of time hardware waits after ORB becomes idle before deasserting the wake signal to the NB. Wait time = WakeHysteresis * 200ns. Changes to this field should be done prior to setting DynWakeEn. |
| 15:10 | Reserved.                                                                                                                                                                                                                                                           |
| 9     | <b>SBDmaActiveMask.</b> Read-write. BIOS: 1. 0=SB_DMA_ACTIVE_L state affects OnInbWake state. 1= SB_DMA_ACTIVE_L state is masked out.                                                                                                                               |
| 8:3   | Reserved.                                                                                                                                                                                                                                                           |
| 2     | Reserved.                                                                                                                                                                                                                                                           |
| 1     | <b>DynWakeEn.</b> Read-write. BIOS: 1. 1=Enable dynamic toggling of the wake signal between ORB and NB. 0=Disable dynamic toggling of the wake signal. See WakeHysteresis.                                                                                          |
| 0     | Reserved.                                                                                                                                                                                                                                                           |

**D0F0x98\_x37 ORB Allow LDTSTOP Control 0**

Reset: 0020\_0000h.

| Bits  | Description                                                                                                                                                  |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:28 | Reserved.                                                                                                                                                    |
| 27:16 | <b>LDTStopHystersis.</b> Read-write. Specifies the number of timer periods (200 ns) the AllowLDTStop signal is held low before ORB asserts the signal again. |
| 15:2  | Reserved.                                                                                                                                                    |
| 1     | <b>DmaActiveOutEn.</b> Read-write. 1=Enable ORB to drive the DMAACTIVE_L pin. Meaningful only when <a href="#">D0F0x98_x37[AllowLDTStopPinMode]</a> ==0.     |
| 0     | <b>AllowLDTStopPinMode.</b> Read-write. Indicates the definition of the ALLOW_LDTSTOP pin. 0=Pin is used as DMAACTIVE_L. 1=Pin is used as ALLOW_LDTSTOP.     |

**D0F0x98\_x3A ORB Source Tag Translation Control 2**

Reset: 0000\_0000h.

| Bits | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:0 | <p><b>ClumpingEn.</b> Read-write. BIOS should follow the below requirements.</p> <p>Valid only for PGD, PPD, PSD and GBIF client clumping; internal unit ID ranges 4h-7h, 8h-Ch, Fh-13h, and 14h-17h respectively.</p> <p>Legal PGD clumping settings are: [7:4]=1010b, applicable only in x8/8 system configuration, [7:4]=1110b, applicable only in x0/16 system configuration..</p> <p>Legal PPD clumping settings are: [12:8]=00010b, applicable only in x0/0/0/0/8 system configuration.</p> <p>Legal PSD clumping settings are: [19:15]=00010b, applicable only in x0/0/0/0/8 system configuration.</p> <p>Legal GBIF clumping settings are: [23:20]=0010b, 0110b and 1110b which are applicable in any system configuration. 1110b is the recommended value.</p> <p>All other bits of this register must always remain 0. See D18F0x[11C,118,114,110].</p> |

### D0F0x98\_x3B ORB Source Tag Translation Control 3

Reset: 0000\_0000h.

| Bits | Description                                                                                                         |
|------|---------------------------------------------------------------------------------------------------------------------|
| 31:0 | <p><b>IocOutstandingMask.</b> Read-write. Limit number of outstanding requests for very dma client via the IOC.</p> |

### D0F0x98\_x4[A,9] ORB LCLK Clock Control 1-0

Reset: 7F3F\_8100h.

| Bits | Description                                                                              |
|------|------------------------------------------------------------------------------------------|
| 31   | Reserved.                                                                                |
| 30   | <p><b>SoftOverrideClk0.</b> Read-write.</p> <p>BIOS: 0.</p> <p>See SoftOverrideClk6.</p> |
| 29   | <p><b>SoftOverrideClk1.</b> Read-write.</p> <p>BIOS: 0.</p> <p>See SoftOverrideClk6.</p> |
| 28   | <p><b>SoftOverrideClk2.</b> Read-write.</p> <p>BIOS: 0.</p> <p>See SoftOverrideClk6.</p> |
| 27   | <p><b>SoftOverrideClk3.</b> Read-write.</p> <p>BIOS: 0.</p> <p>See SoftOverrideClk6.</p> |
| 26   | <p><b>SoftOverrideClk4.</b> Read-write.</p> <p>BIOS: 0.</p> <p>See SoftOverrideClk6.</p> |
| 25   | <p><b>SoftOverrideClk5.</b> Read-write.</p> <p>BIOS: 0.</p> <p>See SoftOverrideClk6.</p> |

|      |                                                                                                      |
|------|------------------------------------------------------------------------------------------------------|
| 24   | <b>SoftOverrideClk6.</b> Read-write.<br>BIOS: 0.<br>1=Clock gating disabled. 0=Clock gating enabled. |
| 23:0 | Reserved.                                                                                            |

### D0F0xB8 SMU Index Address

The index/data pair registers, [D0F0xB8](#) and [D0F0xBC](#), are used to access the registers at [D0F0xBC\\_x\[FFFFFFFF:00000000\]](#). To access any of these registers, the address is first written into the index register, [D0F0xB8](#), and then the data is read from or written to the data register, [D0F0xBC](#).

| Bits | Description                                                   |
|------|---------------------------------------------------------------|
| 31:0 | <b>NbSmuIndAddr: smu index address.</b> Read-write. Reset: 0. |

### D0F0xBC SMU Index Data

See [D0F0xB8](#). Address: [D0F0xB8\[NbSmuIndAddr\]](#).

| Bits | Description                                    |
|------|------------------------------------------------|
| 31:0 | <b>NbSmuIndData: smu index data.</b> Reset: 0. |

### D0F0xBC\_x3F800 FIRMWARE\_FLAGS

Reset: xxxx\_xxxxh.

| Bits  | Description                                                                                                                                                                                                                                                                                                                                     |      |            |   |                                                                                                 |   |                                                                                  |
|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------------|---|-------------------------------------------------------------------------------------------------|---|----------------------------------------------------------------------------------|
| 31:24 | <b>TestCount.</b> Read-write. Test count.                                                                                                                                                                                                                                                                                                       |      |            |   |                                                                                                 |   |                                                                                  |
| 23:1  | Reserved.                                                                                                                                                                                                                                                                                                                                       |      |            |   |                                                                                                 |   |                                                                                  |
| 0     | <b>InterruptsEnabled.</b> Read-write.<br><table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>0</td><td>Firmware has not yet enabled interrupts. BIOS/Driver cannot yet send message interrupts to SMC.</td></tr> <tr> <td>1</td><td>Firmware has enabled interrupts. BIOS/Driver can send message interrupts to SMC.</td></tr> </table> | Bits | Definition | 0 | Firmware has not yet enabled interrupts. BIOS/Driver cannot yet send message interrupts to SMC. | 1 | Firmware has enabled interrupts. BIOS/Driver can send message interrupts to SMC. |
| Bits  | Definition                                                                                                                                                                                                                                                                                                                                      |      |            |   |                                                                                                 |   |                                                                                  |
| 0     | Firmware has not yet enabled interrupts. BIOS/Driver cannot yet send message interrupts to SMC.                                                                                                                                                                                                                                                 |      |            |   |                                                                                                 |   |                                                                                  |
| 1     | Firmware has enabled interrupts. BIOS/Driver can send message interrupts to SMC.                                                                                                                                                                                                                                                                |      |            |   |                                                                                                 |   |                                                                                  |

### D0F0xBC\_x3F804 FIRMWARE\_VID

Reset: xxxx\_xxxxh.

| Bits | Description                                                                         |
|------|-------------------------------------------------------------------------------------|
| 7:0  | <b>FirmwareVid.</b> Read-write. Current voltage set by firmware voltage controller. |

### D0F0xBC\_x3F820 PM\_INTERVAL\_CNTL\_0

Reset: xxxx\_xxxxh.

| Bits  | Description                  |
|-------|------------------------------|
| 31:24 | <b>Loadline.</b> Read-write. |



|       |                                 |
|-------|---------------------------------|
| 23:16 | <b>VoltageCntl.</b> Read-write. |
| 15:8  | <b>ThermalCntl.</b> Read-write. |
| 7:0   | <b>LclkDpm.</b> Read-write.     |

**D0F0xBC\_x3F828 PM\_TIMER\_PERIOD**

| Bits | Description                                                                                                                                                 |
|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:0 | <b>TimerPeriod.</b> Read-write. Reset: X. Specifies the period at which various power management related algorithms are run. Period = TimerPeriod / REFCLK. |

**D0F0xBC\_x3F9E8 NB\_DPM\_CONFIG\_1**

Reset: xxxx\_xxxxh.

| Bits  | Description                                                                                                                                                                                                                                                                                                                 |      |                    |     |                                |     |                                |     |                                |     |                                |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|--------------------|-----|--------------------------------|-----|--------------------------------|-----|--------------------------------|-----|--------------------------------|
| 31:24 | <b>DpmXNbPsHi.</b> Read-write. See: Dpm0PgNbPsLo.                                                                                                                                                                                                                                                                           |      |                    |     |                                |     |                                |     |                                |     |                                |
| 23:16 | <b>DpmXNbPsLo.</b> Read-write. See: Dpm0PgNbPsLo.                                                                                                                                                                                                                                                                           |      |                    |     |                                |     |                                |     |                                |     |                                |
| 15:8  | <b>Dpm0PgNbPsHi.</b> Read-write. See: Dpm0PgNbPsLo.                                                                                                                                                                                                                                                                         |      |                    |     |                                |     |                                |     |                                |     |                                |
| 7:0   | <b>Dpm0PgNbPsLo.</b> Read-write. Indexes the NB P-state used during specific levels of GPU activity. See 2.5.4.1 [NB P-states].                                                                                                                                                                                             |      |                    |     |                                |     |                                |     |                                |     |                                |
|       | <table> <tr> <th>Bits</th><th>NB P-state Indexed</th></tr> <tr> <td>00b</td><td>D18F3x160 (see D18F5x16[C:0]).</td></tr> <tr> <td>01b</td><td>D18F3x164 (see D18F5x16[C:0]).</td></tr> <tr> <td>10b</td><td>D18F3x168 (see D18F5x16[C:0]).</td></tr> <tr> <td>11b</td><td>D18F3x16C (see D18F5x16[C:0]).</td></tr> </table> | Bits | NB P-state Indexed | 00b | D18F3x160 (see D18F5x16[C:0]). | 01b | D18F3x164 (see D18F5x16[C:0]). | 10b | D18F3x168 (see D18F5x16[C:0]). | 11b | D18F3x16C (see D18F5x16[C:0]). |
| Bits  | NB P-state Indexed                                                                                                                                                                                                                                                                                                          |      |                    |     |                                |     |                                |     |                                |     |                                |
| 00b   | D18F3x160 (see D18F5x16[C:0]).                                                                                                                                                                                                                                                                                              |      |                    |     |                                |     |                                |     |                                |     |                                |
| 01b   | D18F3x164 (see D18F5x16[C:0]).                                                                                                                                                                                                                                                                                              |      |                    |     |                                |     |                                |     |                                |     |                                |
| 10b   | D18F3x168 (see D18F5x16[C:0]).                                                                                                                                                                                                                                                                                              |      |                    |     |                                |     |                                |     |                                |     |                                |
| 11b   | D18F3x16C (see D18F5x16[C:0]).                                                                                                                                                                                                                                                                                              |      |                    |     |                                |     |                                |     |                                |     |                                |

**D0F0xBC\_x3F9EC NB\_DPM\_CONFIG\_2**

Reset: xxxx\_xxxxh.

| Bits  | Description                                                                                                                                                                                                                                                                  |
|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:25 | Reserved.                                                                                                                                                                                                                                                                    |
| 24    | <b>EnableNbPsi1.</b> Read-write. Specifies how PSI1_L functions for VDDNB. 0=PSI1_L is deasserted. 1=PSI1_L is asserted whenever the GPU is idle.                                                                                                                            |
| 23:17 | Reserved.                                                                                                                                                                                                                                                                    |
| 16    | <b>SkipDPM0.</b> Read-write. Specifies whether SMU waits for SCLK DPM to transition to state 0 before transitioning NB to the NB P-states indexed Dpm0PgNbPsHi and Dpm0PgNbPsLo. 0=Wait for SCLK DPM state 0. 1=Do not wait for SCLK DPM state 0. See 2.5.4.1 [NB P-states]. |
| 15:9  | Reserved.                                                                                                                                                                                                                                                                    |
| 8     | <b>SkipPG.</b> Read-write. Specifies whether SMU waits for the GPU to be power gated before transitioning NB to the NB P-states indexed Dpm0PgNbPsHi and Dpm0PgNbPsLo. 0=Wait for GPU power gating. 1=Do not wait for GPU power gating. See 2.5.4.1 [NB P-states].           |
| 7:0   | <b>Hysteresis.</b> Read-write. Specifies the time the GPU must be idle before transitioning to the NB P-states indexed by Dpm0PgNbPsHi and Dpm0PgNbPsLo.                                                                                                                     |

**D0F0xBC\_x3FD[8C:00:step14] LCLK DPM Control 0**

Reset: xxxx\_xxxxh. See 2.5.6.1.3 [LCLK DPM]. Each register in [D0F0xBC\\_x3FD\[8C:00:step14\]](#) corresponds to one LCLK DPM state as follows.

Table 62: [Register Mapping](#) for [D0F0xBC\\_x3FD\[8C:00:step14\]](#)

| Register       | Function | Register       | Function |
|----------------|----------|----------------|----------|
| D0F0xBC_x3FD00 | State 0  | D0F0xBC_x3FD50 | State 4  |
| D0F0xBC_x3FD14 | State 1  | D0F0xBC_x3FD64 | State 5  |
| D0F0xBC_x3FD28 | State 2  | D0F0xBC_x3FD78 | State 6  |
| D0F0xBC_x3FD3C | State 3  | D0F0xBC_x3FD8C | State 7  |

| Bits  | Description                                                                     |
|-------|---------------------------------------------------------------------------------|
| 31:24 | <b>StateValid</b> . Read-write. 1=DPM state is valid. 0=DPM state is invalid.   |
| 23:16 | <b>LclkDivider</b> . Read-write. Specifies the LCLK divisor for this DPM state. |
| 15:8  | <b>VID</b> . Read-write. Specifies the VDDNB VID for this DPM state.            |
| 7:0   | <b>LowVoltageReqThreshold</b> . Read-write.                                     |

**D0F0xBC\_x3FD[94:08:step14] LCLK DPM Control 2**

Reset: xxxx\_xxxxh. Each register in [D0F0xBC\\_x3FD\[94:08:step14\]](#) corresponds to one LCLK DPM state as follows.

Table 63: [Register Mapping](#) for [D0F0xBC\\_x3FD\[94:08:step14\]](#)

| Register       | Function | Register       | Function |
|----------------|----------|----------------|----------|
| D0F0xBC_x3FD08 | State 0  | D0F0xBC_x3FD58 | State 4  |
| D0F0xBC_x3FD1C | State 1  | D0F0xBC_x3FD6C | State 5  |
| D0F0xBC_x3FD30 | State 2  | D0F0xBC_x3FD80 | State 6  |
| D0F0xBC_x3FD44 | State 3  | D0F0xBC_x3FD94 | State 7  |

| Bits  | Description                           |
|-------|---------------------------------------|
| 31:16 | <b>ResidencyCounter</b> . Read-write. |
| 15:8  | <b>HysteresisUp</b> . Read-write.     |
| 7:0   | <b>HysteresisDown</b> . Read-write.   |

**D0F0xBC\_x3FD[9C:10:step14] LCLK DPM Activity Thresholds**

Reset: xxxx\_xxxxh. Each register in [D0F0xBC\\_x3FD\[9C:10:step14\]](#) corresponds to one LCLK DPM state as follows.

Table 64: [Register Mapping](#) for [D0F0xBC\\_x3FD\[9C:10:step14\]](#)

| Register       | Function | Register       | Function |
|----------------|----------|----------------|----------|
| D0F0xBC_x3FD10 | State 0  | D0F0xBC_x3FD60 | State 4  |

Table 64: Register Mapping for D0F0xBC\_x3FD[9C:10:step14]

|                |         |                |         |
|----------------|---------|----------------|---------|
| D0F0xBC_x3FD24 | State 1 | D0F0xBC_x3FD74 | State 5 |
| D0F0xBC_x3FD38 | State 2 | D0F0xBC_x3FD88 | State 6 |
| D0F0xBC_x3FD4C | State 3 | D0F0xBC_x3FD9C | State 7 |

| Bits  | Description                             |
|-------|-----------------------------------------|
| 31:24 | <b>ActivityThreshold</b> . Read-write.  |
| 23:16 | <b>EnabledForThrottle</b> . Read-write. |
| 15:0  | Reserved.                               |

**D0F0xBC\_x3FDC8 SMU\_LCLK\_DPM\_CNTL**

Reset: xxxx\_xxxxh.

| Bits  | Description                                                                                 |
|-------|---------------------------------------------------------------------------------------------|
| 31:24 | <b>LclkDpmEn</b> . Read-write. 1b=Enable LCLK DPM                                           |
| 23:16 | <b>VoltageChgEn</b> . Read-write. 1=Enable voltage change during LCLK DPM state transition. |
| 15:8  | <b>LclkDpmBootState</b> . Read-write.                                                       |
| 7:0   | Reserved.                                                                                   |

**D0F0xBC\_x3FDD0 SMU\_LCLK\_DPM\_THERMAL\_THROTTLING\_CNTL**

Reset: xxxx\_xxxxh.

| Bits  | Description                                  |
|-------|----------------------------------------------|
| 31:24 | <b>TtHtcActive</b> . Read-write.             |
| 23:16 | <b>LclkTtMode</b> . Read-write.              |
| 15:8  | <b>TemperatureSel</b> . Read-write.          |
| 7:0   | <b>LclkThermalThrottlingEn</b> . Read-write. |

**D0F0xBC\_x3FDD4 SMU\_LCLK\_DPM\_THERMAL\_THROTTLING\_THRESHOLDS**

Reset: xxxx\_xxxxh.

| Bits  | Description                                                                                          |
|-------|------------------------------------------------------------------------------------------------------|
| 31:16 | <b>HighThreshold</b> . Read-write. Specifies the high thermal threshold for LCLK thermal throttling. |
| 15:0  | <b>LowThreshold</b> . Read-write. Specifies the low thermal threshold for LCLK thermal throttling.   |

**D0F0xBC\_xC010\_40A0 SVI Loadline Configuration**

| Bits  | Description |
|-------|-------------|
| 31:27 | Reserved.   |

|       |                                                                            |
|-------|----------------------------------------------------------------------------|
| 26:25 | <b>SviLoadLineOffsetVddNb</b> . Read-only. Reset: value varies by product. |
| 24:23 | <b>SviLoadLineOffsetVdd</b> . Read-only. Reset: value varies by product.   |
| 22:20 | <b>SviLoadLineTrimVddNb</b> . Read-only. Reset: value varies by product.   |
| 19:17 | <b>SviLoadLineTrimVdd</b> . Read-only. Reset: value varies by product.     |
| 16:10 | <b>SviLoadLineVddNb</b> . Read-only. Reset: value varies by product.       |
| 9:3   | <b>SviLoadLineVdd</b> . Read-only. Reset: value varies by product.         |
| 2:0   | Reserved.                                                                  |

#### D0F0xBC\_xC020\_0110 Activity Monitor Control

| Bits        | Description                                                                                                                                                                                                                                                                                                                                                                                                                 |             |                            |             |                   |     |               |     |                     |     |                   |     |                            |
|-------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|----------------------------|-------------|-------------------|-----|---------------|-----|---------------------|-----|-------------------|-----|----------------------------|
| 31:11       | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                   |             |                            |             |                   |     |               |     |                     |     |                   |     |                            |
| 10          | <b>EnOrbDsCnt</b> . Read-write. Reset: X. 1=Enable downstream counter.                                                                                                                                                                                                                                                                                                                                                      |             |                            |             |                   |     |               |     |                     |     |                   |     |                            |
| 9           | <b>EnOrbUsCnt</b> . Read-write. Reset: X. 1=Enable upstream counter.                                                                                                                                                                                                                                                                                                                                                        |             |                            |             |                   |     |               |     |                     |     |                   |     |                            |
| 8           | <b>EnBifCnt</b> . Read-write. Reset: X. 1=Enable BIF counter.                                                                                                                                                                                                                                                                                                                                                               |             |                            |             |                   |     |               |     |                     |     |                   |     |                            |
| 7:5         | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                   |             |                            |             |                   |     |               |     |                     |     |                   |     |                            |
| 4:3         | <b>BusyCntSel</b> . Read-write. Reset: 0. Specifies subcomponents or activity monitored by the LCLK activity monitor. <table><tr><td><u>Bits</u></td><td><u>Definition</u></td><td><u>Bits</u></td><td><u>Definition</u></td></tr><tr><td>00b</td><td>GFX DMA (BIF)</td><td>10b</td><td>Downstream activity</td></tr><tr><td>01b</td><td>Upstream activity</td><td>11b</td><td>Up/downstream activity max</td></tr></table> | <u>Bits</u> | <u>Definition</u>          | <u>Bits</u> | <u>Definition</u> | 00b | GFX DMA (BIF) | 10b | Downstream activity | 01b | Upstream activity | 11b | Up/downstream activity max |
| <u>Bits</u> | <u>Definition</u>                                                                                                                                                                                                                                                                                                                                                                                                           | <u>Bits</u> | <u>Definition</u>          |             |                   |     |               |     |                     |     |                   |     |                            |
| 00b         | GFX DMA (BIF)                                                                                                                                                                                                                                                                                                                                                                                                               | 10b         | Downstream activity        |             |                   |     |               |     |                     |     |                   |     |                            |
| 01b         | Upstream activity                                                                                                                                                                                                                                                                                                                                                                                                           | 11b         | Up/downstream activity max |             |                   |     |               |     |                     |     |                   |     |                            |
| 2           | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                   |             |                            |             |                   |     |               |     |                     |     |                   |     |                            |
| 1           | <b>PeriodCntRst</b> . Read-write. Reset: X.                                                                                                                                                                                                                                                                                                                                                                                 |             |                            |             |                   |     |               |     |                     |     |                   |     |                            |
| 0           | <b>ActivityCntRst</b> . Read-write. Reset: X.                                                                                                                                                                                                                                                                                                                                                                               |             |                            |             |                   |     |               |     |                     |     |                   |     |                            |

#### D0F0xBC\_xC210\_0000 CPU Interrupt Request

See [2.13.1 \[Software Interrupts\]](#).

| Bits  | Description                                 |
|-------|---------------------------------------------|
| 31:17 | Reserved.                                   |
| 16:1  | <b>ServiceIndex</b> . Read-write. Reset: 0. |
| 0     | <b>IntToggle</b> . Read-write. Reset: 0.    |

#### D0F0xBC\_xC210\_0004 CPU Interrupt Status

See [2.13.1 \[Software Interrupts\]](#).

| Bits | Description                                                |
|------|------------------------------------------------------------|
| 31:2 | Reserved.                                                  |
| 1    | <b>IntDone</b> . Read-only; updated-by-hardware. Reset: 0. |
| 0    | <b>IntAck</b> . Read-only; updated-by-hardware. Reset: 0.  |

**D0F0xBC\_xC210\_003C CPU Interrupt Argument**

See 2.13.1 [Software Interrupts].

| Bits | Description                                                                        |
|------|------------------------------------------------------------------------------------|
| 31:0 | <b>Argument.</b> Read-write. Reset: 0. Optional argument for a software interrupt. |

**D0F0xBC\_xC210\_0040 CPU Interrupt Response**

See 2.13.1 [Software Interrupts].

| Bits | Description                                                                                         |
|------|-----------------------------------------------------------------------------------------------------|
| 31:0 | <b>Argument.</b> Read-write. Reset: 0. Optional response data upon completing a software interrupt. |

**D0F0xBC\_xE000\_3040 CONNECTED\_STANDBY\_CONTROL**

| Bits | Description                                |
|------|--------------------------------------------|
| 31:2 | Reserved.                                  |
| 1    | <b>S0i3_HINT[1].</b> Read-write. Reset: 0. |
| 0    | <b>S0i3_HINT[0].</b> Read-write. Reset: 0. |

**D0F0xC8 DEV Index Address**

The index/data pair registers, [D0F0xC8](#) and [D0F0xCC](#) are used to access the registers at [D0F0xCC\\_x\[FF:00\]](#). To access any of these registers, the address is first written into the index register, [D0F0xC8](#), and then the data is read from or written to the data register, [D0F0xCC](#). Specific IOC bridges (Device/Function) are selected using the [D0F0xC8\[NbDevIndSel\]](#) field and enumerated as *\_ib[21,1D:19,12:11]* in the indexed register's mnemonic.

| Bits  | Description                                                               |                   |             |                   |
|-------|---------------------------------------------------------------------------|-------------------|-------------|-------------------|
| 31:24 | Reserved.                                                                 |                   |             |                   |
| 23:16 | <b>NbDevIndSel: Device selector.</b> Read-write. Reset: 0.                |                   |             |                   |
|       | <u>Bits</u>                                                               | <u>Definition</u> | <u>Bits</u> | <u>Definition</u> |
|       | 10h-00h                                                                   | Reserved          | 1Bh         | D3F3              |
|       | 11h                                                                       | D2F1              | 1Ch         | D3F4              |
|       | 12h                                                                       | D2F2              | 1Dh         | D3F5              |
|       | 18h-13h                                                                   | Reserved          | 20h-1Eh     | Reserved          |
|       | 19h                                                                       | D3F1              | 21h         | D4F1              |
|       | 1Ah                                                                       | D3F2              | FFh-22h     | Reserved          |
| 15:7  | Reserved.                                                                 |                   |             |                   |
| 6:0   | <b>NbDevIndAddr: Bridge (Device) index address.</b> Read-write. Reset: 0. |                   |             |                   |

**D0F0xCC DEV Index Data**

See [D0F0xC8](#). Address: [D0F0xC8\[NbDevIndAddr\]](#).

| Bits | Description                          |
|------|--------------------------------------|
| 31:0 | <b>NbDevIndData:</b> dev index data. |

### D0F0xCC\_x01\_ib[21,1D:19,12:11] IOC Bridge Control

Reset: 0000\_0000h.

| Bits  | Description                                                                                                                                               |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:24 | <b>ApicRange.</b> Read-write. Sets the bridge APIC range.                                                                                                 |
| 23    | <b>ApicEnable.</b> Read-write. 1=Enables the bridge APIC range decoding. Requests fall in bridge APIC range if addr[39:12]={20'h00_FEC, APIC_Range[7:0]}. |
| 22:21 | Reserved.                                                                                                                                                 |
| 20    | <b>SetPowEn.</b> Read-write. BIOS: 1h. 1=Enable generation of set_slot_power message to the bridge.                                                       |
| 19    | Reserved.                                                                                                                                                 |
| 18    | <b>CrsEnable.</b> Read-write. BIOS: 1h. 1=Enables the hardware retry on receiving configuration request retry status.                                     |
| 17    | <b>ExtDevCrsEn.</b> Read-write. 1=Reset the bridge CRS counter when an external device is plugged in or the link is down.                                 |
| 16    | <b>ExtDevPlug.</b> Read-write. 1=Indicates to IOC that an external device is being plugged on the bridge.                                                 |
| 15:7  | Reserved.                                                                                                                                                 |
| 6     | Reserved.                                                                                                                                                 |
| 5     | Reserved.                                                                                                                                                 |
| 4     | Reserved.                                                                                                                                                 |
| 3     | <b>P2pDis.</b> Read-write. 1=Disables local peer-to-peer transactions forwarded to this bridge.                                                           |
| 2     | <b>CfgDis.</b> Read-write. 1=Configuration accesses to this bridge are disabled. Non-FCH bridges are not expected to set this bit.                        |
| 1     | <b>BusMasterDis.</b> Read-write. 1=The bridge's ability to operate as a bus master is disabled. This overrides the Bus Master Enable bit in the bridge.   |
| 0     | <b>BridgeDis.</b> Read-write. 1=The bridge is hidden and no accesses are allowed to this bridge.                                                          |

### D0F0xCC\_x02\_ib[21,1D:19,12:11] IOC Bridge Status

Reset: 0000\_0000h.

| Bits | Description                                                                                 |
|------|---------------------------------------------------------------------------------------------|
| 31:1 | Reserved.                                                                                   |
| 0    | <b>MaskURStatus.</b> Read; Write-1-to-clear. 1=A host completion with UR status was masked. |

### D0F0xD0 GBIF Index Address

The index/data pair registers, [D0F0xD0](#) and [D0F0xD4](#) are used to access the registers at [D0F0xD4\\_x\[FFFF\\_FFFF:0000\\_0000\]](#). To access any of these registers, the address is first written into the

index register, [D0F0xD0](#), and then the data is read from or written to the data register, [D0F0xD4](#).

| Bits | Description                                                     |
|------|-----------------------------------------------------------------|
| 31:0 | <b>NbGbifIndAddr: Gbif index address.</b> Read-write. Reset: 0. |

#### **D0F0xD4 GBIF Index Data**

See [D0F0xD0](#). Address: [D0F0xD0](#)[NbGbifIndAddr].

| Bits | Description                                      |
|------|--------------------------------------------------|
| 31:0 | <b>NbGbifIndData: Gbif index data.</b> Reset: 0. |

#### **D0F0xD4\_x0109\_14E1 CC Bif Bx Strap0 Ind**

Reset: 0000\_C004h.

| Bits  | Description                                |
|-------|--------------------------------------------|
| 31:13 | Reserved.                                  |
| 12    | <b>StrapBifDoorbellBarDis.</b> Read-write. |
| 11:6  | Reserved.                                  |
| 5:3   | <b>StrapBifMemApSize.</b> Read-write.      |
| 2:1   | <b>StrapBifRegApSize.</b> Read-write.      |
| 0     | Reserved.                                  |

#### **D0F0xD4\_x0109\_14E2 CC Bif Bx Strap1 Ind**

Reset: 0000\_0000h.

| Bits  | Description                             |
|-------|-----------------------------------------|
| 31:14 | Reserved.                               |
| 13    | Reserved.                               |
| 12:11 | Reserved.                               |
| 10    | Reserved.                               |
| 9     | Reserved.                               |
| 8     | Reserved.                               |
| 7:4   | Reserved.                               |
| 3     | <b>StrapBifF064BarDisA.</b> Read-write. |
| 2     | Reserved.                               |
| 1     | <b>StrapBifIoBarDis.</b> Read-write.    |
| 0     | Reserved.                               |

#### **D0F0xD4\_x0109\_1507 CC Bif Bx Pinstrap0 Ind**

Reset: 0000\_0802h.

| Bits  | Description                              |
|-------|------------------------------------------|
| 31:17 | Reserved.                                |
| 16    | Reserved.                                |
| 15:8  | Reserved.                                |
| 7:5   | <b>StrapBifMemApSizePin.</b> Read-write. |
| 4:0   | Reserved.                                |

### D0F0xE0 Link Index Address

Reset: 0130\_8001h.

**D0F0xE0** and **D0F0xE4** are used to access **D0F0xE4\_x**[FFFF\_FFFF:0000\_0000]. To read or write to one of these register, the address is written first into the address register **D0F0xE0** and then the data is read from or written to the data register **D0F0xE4**.

The phy index registers (**D0F0xE4\_x0**[2:1]xxx\_xxxx]) mapping to a specific phy, pin or pin group is shown in a table in the register definition. For example, to perform a read or write operation to configure Gfx phy 0 (P\_GFX\_[T,R]X[P,N][7:0] pin group) compensation, software should program **D0F0xE0**[31:0]=0120\_0000h. Accessing any register number that is not listed in the mapping table may result in undefined behavior.

Some phy registers support broadcast write operations to groups of 4 or 8 lanes. For example, to perform broadcast write operation to configure Gfx Link[3:0] (P\_GFX\_RX[P,N][3:0] lanes) receiver phase loop filter, software should program **D0F0xE0**[31:0]=0120\_5602h.

| Bits             | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                  |                    |     |                                                           |     |                                       |     |                    |     |                    |          |                       |    |                |    |                |    |          |    |     |
|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|--------------------|-----|-----------------------------------------------------------|-----|---------------------------------------|-----|--------------------|-----|--------------------|----------|-----------------------|----|----------------|----|----------------|----|----------|----|-----|
| 31:24            | <b>BlockSelect: block select.</b> Read-write. This field is used to select the specific register block to access. The encodings supported depends on the FrameType selected. <table> <tr> <td><u>FrameType</u></td><td><u>Encoding</u></td></tr> <tr> <td>1xh</td><td>1=Phy interface 0, 2=Phy interface 1 (FrameType 12h only)</td></tr> <tr> <td>2xh</td><td>1=Phy 0, 2=Phy 1 (FrameType 22h only)</td></tr> <tr> <td>3xh</td><td>1=Wrapper</td></tr> <tr> <td>4xh</td><td>1=IO link core</td></tr> </table>                                                                                                                       | <u>FrameType</u> | <u>Encoding</u>    | 1xh | 1=Phy interface 0, 2=Phy interface 1 (FrameType 12h only) | 2xh | 1=Phy 0, 2=Phy 1 (FrameType 22h only) | 3xh | 1=Wrapper          | 4xh | 1=IO link core     |          |                       |    |                |    |                |    |          |    |     |
| <u>FrameType</u> | <u>Encoding</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                  |                    |     |                                                           |     |                                       |     |                    |     |                    |          |                       |    |                |    |                |    |          |    |     |
| 1xh              | 1=Phy interface 0, 2=Phy interface 1 (FrameType 12h only)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                  |                    |     |                                                           |     |                                       |     |                    |     |                    |          |                       |    |                |    |                |    |          |    |     |
| 2xh              | 1=Phy 0, 2=Phy 1 (FrameType 22h only)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                  |                    |     |                                                           |     |                                       |     |                    |     |                    |          |                       |    |                |    |                |    |          |    |     |
| 3xh              | 1=Wrapper                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                  |                    |     |                                                           |     |                                       |     |                    |     |                    |          |                       |    |                |    |                |    |          |    |     |
| 4xh              | 1=IO link core                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                  |                    |     |                                                           |     |                                       |     |                    |     |                    |          |                       |    |                |    |                |    |          |    |     |
| 23:16            | <b>FrameType: frame type.</b> Read-write. This field is used to select the type of register block to access. <table> <tr> <td><u>Bits</u></td><td><u>Destination</u></td></tr> <tr> <td>1Nh</td><td>Phy interface block registers.</td></tr> <tr> <td>2Nh</td><td>Phy registers.</td></tr> <tr> <td>3Nh</td><td>Wrapper registers.</td></tr> <tr> <td>4Nh</td><td>IO Link registers.</td></tr> <tr> <td><u>N</u></td><td><u>Register Block</u></td></tr> <tr> <td>0h</td><td>Gfx PCIe links</td></tr> <tr> <td>1h</td><td>GPP PCIe Links</td></tr> <tr> <td>2h</td><td>FCH link</td></tr> <tr> <td>3h</td><td>DDI</td></tr> </table> | <u>Bits</u>      | <u>Destination</u> | 1Nh | Phy interface block registers.                            | 2Nh | Phy registers.                        | 3Nh | Wrapper registers. | 4Nh | IO Link registers. | <u>N</u> | <u>Register Block</u> | 0h | Gfx PCIe links | 1h | GPP PCIe Links | 2h | FCH link | 3h | DDI |
| <u>Bits</u>      | <u>Destination</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                  |                    |     |                                                           |     |                                       |     |                    |     |                    |          |                       |    |                |    |                |    |          |    |     |
| 1Nh              | Phy interface block registers.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                  |                    |     |                                                           |     |                                       |     |                    |     |                    |          |                       |    |                |    |                |    |          |    |     |
| 2Nh              | Phy registers.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                  |                    |     |                                                           |     |                                       |     |                    |     |                    |          |                       |    |                |    |                |    |          |    |     |
| 3Nh              | Wrapper registers.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                  |                    |     |                                                           |     |                                       |     |                    |     |                    |          |                       |    |                |    |                |    |          |    |     |
| 4Nh              | IO Link registers.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                  |                    |     |                                                           |     |                                       |     |                    |     |                    |          |                       |    |                |    |                |    |          |    |     |
| <u>N</u>         | <u>Register Block</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                  |                    |     |                                                           |     |                                       |     |                    |     |                    |          |                       |    |                |    |                |    |          |    |     |
| 0h               | Gfx PCIe links                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                  |                    |     |                                                           |     |                                       |     |                    |     |                    |          |                       |    |                |    |                |    |          |    |     |
| 1h               | GPP PCIe Links                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                  |                    |     |                                                           |     |                                       |     |                    |     |                    |          |                       |    |                |    |                |    |          |    |     |
| 2h               | FCH link                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                  |                    |     |                                                           |     |                                       |     |                    |     |                    |          |                       |    |                |    |                |    |          |    |     |
| 3h               | DDI                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                  |                    |     |                                                           |     |                                       |     |                    |     |                    |          |                       |    |                |    |                |    |          |    |     |
| 15:0             | <b>PcieIndxAddr: index address.</b> Read-write.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                  |                    |     |                                                           |     |                                       |     |                    |     |                    |          |                       |    |                |    |                |    |          |    |     |



**D0F0xE4 Link Index Data**

See [D0F0xE0](#). Address: {[D0F0xE0](#)[BlockSelect],[D0F0xE0](#)[FrameType],[D0F0xE0](#)[PcieIndxAddr]}.

| Bits | Description                      |
|------|----------------------------------|
| 31:0 | <b>PcieIndxData: index data.</b> |

**3.3.1 PIF Registers****Table 65: Mapping for PIF registers**

| <a href="#">D0F0xE0</a> [31:16] | Wrapper  | Port Description |
|---------------------------------|----------|------------------|
| 0110h                           | PGD PIF0 | Gfx+Display      |
| 0210h                           | PGD PIF1 | Gfx+Display      |
| 0111h                           | PPD      | GPP+Display      |
| 0112h                           | PSD      | FCH+Display      |
| 0113h                           | DDI      | Display          |

**D0F0xE4\_x0[210,11[3:0]]\_0010 PIF Control**

Reset: 3180\_54D8h.

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                   |      |            |      |            |      |      |      |      |      |      |      |       |      |      |      |       |      |      |      |      |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------------|------|------------|------|------|------|------|------|------|------|-------|------|------|------|-------|------|------|------|------|
| 31:20 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                     |      |            |      |            |      |      |      |      |      |      |      |       |      |      |      |       |      |      |      |      |
| 19:17 | <b>Ls2ExitTime: LS2 exit time.</b> Read-write. <table><tr><th>Bits</th><th>Definition</th><th>Bits</th><th>Definition</th></tr><tr><td>000b</td><td>14us</td><td>100b</td><td>30us</td></tr><tr><td>001b</td><td>10us</td><td>101b</td><td>100ns</td></tr><tr><td>010b</td><td>15us</td><td>110b</td><td>100us</td></tr><tr><td>011b</td><td>20us</td><td>111b</td><td>50us</td></tr></table> | Bits | Definition | Bits | Definition | 000b | 14us | 100b | 30us | 001b | 10us | 101b | 100ns | 010b | 15us | 110b | 100us | 011b | 20us | 111b | 50us |
| Bits  | Definition                                                                                                                                                                                                                                                                                                                                                                                    | Bits | Definition |      |            |      |      |      |      |      |      |      |       |      |      |      |       |      |      |      |      |
| 000b  | 14us                                                                                                                                                                                                                                                                                                                                                                                          | 100b | 30us       |      |            |      |      |      |      |      |      |      |       |      |      |      |       |      |      |      |      |
| 001b  | 10us                                                                                                                                                                                                                                                                                                                                                                                          | 101b | 100ns      |      |            |      |      |      |      |      |      |      |       |      |      |      |       |      |      |      |      |
| 010b  | 15us                                                                                                                                                                                                                                                                                                                                                                                          | 110b | 100us      |      |            |      |      |      |      |      |      |      |       |      |      |      |       |      |      |      |      |
| 011b  | 20us                                                                                                                                                                                                                                                                                                                                                                                          | 111b | 50us       |      |            |      |      |      |      |      |      |      |       |      |      |      |       |      |      |      |      |
| 16:8  | Reserved.                                                                                                                                                                                                                                                                                                                                                                                     |      |            |      |            |      |      |      |      |      |      |      |       |      |      |      |       |      |      |      |      |
| 7     | <b>RxDetectTxPwrMode: receiver detection transmitter power mode.</b> Read-write. 1=Transmitter is powered on.                                                                                                                                                                                                                                                                                 |      |            |      |            |      |      |      |      |      |      |      |       |      |      |      |       |      |      |      |      |
| 6     | <b>RxDetectFifoResetMode: receiver detect FIFO reset mode.</b> Read-write. BIOS: 1. 1=The transmit FIFO is reset after receiver detection. 0=The transmit FIFO is not reset after receiver detection.                                                                                                                                                                                         |      |            |      |            |      |      |      |      |      |      |      |       |      |      |      |       |      |      |      |      |
| 5     | Reserved.                                                                                                                                                                                                                                                                                                                                                                                     |      |            |      |            |      |      |      |      |      |      |      |       |      |      |      |       |      |      |      |      |
| 4     | <b>EiDetCycleMode: electrical idle detect mode.</b> Read-write. 1=Electrical idle cycle detection mode is enabled in L1. 0=Electrical idle detection is always enabled in L1.                                                                                                                                                                                                                 |      |            |      |            |      |      |      |      |      |      |      |       |      |      |      |       |      |      |      |      |
| 3:0   | Reserved.                                                                                                                                                                                                                                                                                                                                                                                     |      |            |      |            |      |      |      |      |      |      |      |       |      |      |      |       |      |      |      |      |

**D0F0xE4\_x0[210,11[3:0]]\_0011 PIF Pairing**

Reset: 0200\_0000h.

| Bits  | Description |
|-------|-------------|
| 31:26 | Reserved.   |

|       |                                                                                                       |
|-------|-------------------------------------------------------------------------------------------------------|
| 25    | <b>MultiPif: x16 link.</b> Read-write. 1=Lanes 7:0 are paired with a second PIF to create a x16 link. |
| 24:21 | Reserved.                                                                                             |
| 20    | <b>X16Lane150: x16 link lanes 15:0.</b> Read-write. 1=Lanes 15:0 are paired to create a x16 link.     |
| 19:18 | Reserved.                                                                                             |
| 17    | <b>X8Lane158: x8 link lanes 15:8.</b> Read-write. 1=Lanes 15:8 are paired to create a x8 link.        |
| 16    | <b>X8Lane70: x8 link lanes 7:0.</b> Read-write. 1=Lanes 7:0 are paired to create a x8 link.           |
| 15:12 | Reserved.                                                                                             |
| 11    | <b>X4Lane1512: x4 link lanes 15:12.</b> Read-write. 1=Lanes 15:12 are paired to create a x4 link.     |
| 10    | <b>X4Lane118: x4 link lanes 11:8.</b> Read-write. 1=Lanes 11:8 are paired to create a x4 link.        |
| 9     | <b>X4Lane74: x4 link lanes 7:4.</b> Read-write. 1=Lanes 7:4 are paired to create a x4 link.           |
| 8     | <b>X4Lane30: x4 link lanes 3:0.</b> Read-write. 1=Lanes 3:0 are paired to create a x4 link.           |
| 7     | <b>X2Lane1514: x2 link lanes 15:14.</b> Read-write. 1=Lanes 15:14 are paired to create a x2 link      |
| 6     | <b>X2Lane1312: x2 link lanes 13:12.</b> Read-write. 1=Lanes 13:12 are paired to create a x2 link      |
| 5     | <b>X2Lane1110: x2 link lanes 11:10.</b> Read-write. 1=Lanes 11:10 are paired to create a x2 link      |
| 4     | <b>X2Lane98: x2 link lanes 9:8.</b> Read-write. 1=Lanes 9:8 are paired to create a x2 link            |
| 3     | <b>X2Lane76: x2 link lanes 7:6.</b> Read-write. 1=Lanes 7:6 are paired to create a x2 link.           |
| 2     | <b>X2Lane54: x2 link lanes 5:4.</b> Read-write. 1=Lanes 5:4 are paired to create a x2 link.           |
| 1     | <b>X2Lane32: x2 link lanes 3:2.</b> Read-write. 1=Lanes 3:2 are paired to create a x2 link.           |
| 0     | <b>X2Lane10: x2 link lanes 1:0.</b> Read-write. 1=Lanes 1:0 are paired to create a x2 link.           |

#### **D0F0xE4\_x0[210,11[3:0]]\_001[8:7,3:2] PIF Power Down Control [3:0]**

Reset: 0001\_1FA2h.

Table 66: Index addresses for [D0F0xE4\\_x0\[210,11\[3:0\]\]\\_001\[8:7,3:2\]](#)

| <a href="#">D0F0xE0[31:16]</a> | <a href="#">D0F0xE0[15:0]</a> |                |               |               |
|--------------------------------|-------------------------------|----------------|---------------|---------------|
|                                | 0018h                         | 0017h          | 0013h         | 0012h         |
| 0110h                          | PIF Lanes 15-12               | PIF Lanes 11-8 | PIF Lanes 7-4 | PIF Lanes 3-0 |
| 0210h                          | PIF Lanes 15-12               | PIF Lanes 11-8 | PIF Lanes 7-4 | PIF Lanes 3-0 |
| 0111h                          | PIF Lanes 15-12               | PIF Lanes 11-8 | PIF Lanes 7-4 | PIF Lanes 3-0 |
| 0112h                          | PIF Lanes 15-12               | PIF Lanes 11-8 | PIF Lanes 7-4 | PIF Lanes 3-0 |
| 0113h                          | PIF Lanes 15-12               | PIF Lanes 11-8 | PIF Lanes 7-4 | PIF Lanes 3-0 |

| Bits  | Description                                                                                                                           |
|-------|---------------------------------------------------------------------------------------------------------------------------------------|
| 31:29 | <b>PlIPwrOverrideVal: PLL power state override value.</b> Read-write. See TxPowerStateInTx2.                                          |
| 28    | <b>PlIPwrOverrideEn: PLL power state override enable.</b> Read-write. 1=PLL forced to the power state specified by PlIPwrOverrideVal. |
| 27    | Reserved.                                                                                                                             |

|       |                                                                                                                                                                                      |                   |             |                   |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|-------------|-------------------|
| 26:24 | <b>PllRampUpTime: PLL ramp time.</b> Read-write.                                                                                                                                     |                   |             |                   |
|       | <u>Bits</u>                                                                                                                                                                          | <u>Definition</u> | <u>Bits</u> | <u>Definition</u> |
|       | 000b                                                                                                                                                                                 | 10 us             | 100b        | 50 us             |
|       | 001b                                                                                                                                                                                 | 5 us              | 101b        | 300 us            |
|       | 010b                                                                                                                                                                                 | 15 us             | 110b        | 500 us            |
|       | 011b                                                                                                                                                                                 | 22 us             | 111b        | 800 us            |
| 23:17 | Reserved.                                                                                                                                                                            |                   |             |                   |
| 16    | <b>Tx2p5clkClockGatingEn.</b> Read-write. 1=The 2.5x TxClk is gated if the lane is idle 0=The 2.5x TxClk is never gated.                                                             |                   |             |                   |
| 15:13 | Reserved.                                                                                                                                                                            |                   |             |                   |
| 12:10 | <b>PllPowerStateInOff: PLL off power state.</b> Read-write. See: TxPowerStateInTxs2. All links associated with the PLL must be in the off state to transition the PLL to this state. |                   |             |                   |
| 9:7   | <b>PllPowerStateInTxs2: PLL L1 power state.</b> Read-write. See: TxPowerStateInTxs2. All links associated with the PLL must be in L1 to transition the PLL to this state.            |                   |             |                   |
| 6:4   | <b>RxPowerStateInRxs2: receiver L1 power state.</b> Read-write. See: TxPowerStateInTxs2.                                                                                             |                   |             |                   |
| 3     | <b>ForceRxEnInL0s: force receiver enable in L0s.</b> Read-write. 1=The phy CDR is always enabled in L0s.                                                                             |                   |             |                   |
| 2:0   | <b>TxPowerStateInTxs2: transmitter L1 power state.</b> Read-write.                                                                                                                   |                   |             |                   |
|       | <u>Bits</u>                                                                                                                                                                          | <u>Definition</u> | <u>Bits</u> | <u>Definition</u> |
|       | 000b                                                                                                                                                                                 | L0                | 100b        | Reserved          |
|       | 001b                                                                                                                                                                                 | LS1               | 101b        | Reserved          |
|       | 010b                                                                                                                                                                                 | LS2               | 110b        | Reserved          |
|       | 011b                                                                                                                                                                                 | Reserved          | 111b        | Off               |

### 3.3.2 Phy Registers

There are three categories of phy registers: 3.3.2.1 [Global Phy Control Registers], receiver lane control registers and transmitter lane control registers.

#### 3.3.2.1 Global Phy Control Registers

Each global phy control register may have one instance per phy or two instances per phy (one per nibble). When a global register is implemented per phy the mapping to signal pins is shown in Table 67. When a global register is implemented per nibble the mapping to pins is shown in Table 67.

**Table 67: Per phy register addresses to pin mappings**

| D0F0xE0[31:0]  | Pin Names                                                   |
|----------------|-------------------------------------------------------------|
| 0120_[2:0]xxxh | Gfx Links[7:0]: P_GFX_[T,R]X[P,N][7:0]                      |
| 0220_[2:0]xxxh | Gfx Links[15:8]: P_GFX_[T,R]X[P,N][15:8]                    |
| 0121_[2:0]xxxh | GPP Links: P_GPP_[T,R]X[P,N][7:0]                           |
| 0122_[2:0]xxxh | FCH ports: DDI 0: DP0_TX[P,N][3:0] & P_UMI_[T,R]X[P,N][3:0] |
| 0123_[2:0]xxxh | DDI 1: DP1_TX[P,N][3:0] & DDI 2: DP2_TX[P,N][3:0] &         |

**Table 68: Per nibble register addresses to pin mappings**

| D0F0xE0[31:12] | Pin Names                                     |                                              |
|----------------|-----------------------------------------------|----------------------------------------------|
|                | Address N+1                                   | Address N                                    |
| 0120_[2:0]xxxh | Graphics port lower: P_GFX_[T,R]X[P,N][7:4]   | Graphics port lower: P_GFX_[T,R]X[P,N][3:0]  |
| 0220_[2:0]xxxh | Graphics port upper: P_GFX_[T,R]X[P,N][15:12] | Graphics port upper: P_GFX_[T,R]X[P,N][11:8] |
| 0121_[2:0]xxxh | GPP ports: P_GPP_[T,R]X[P,N][7:4]             | GPP ports: P_GPP_[T,R]X[P,N][3:0]            |
| 0122_[2:0]xxxh | DDI 0: DP0_TX[P,N][3:0]                       | FCH ports: P_UMI_[T,R]X[P,N][3:0]            |
| 0123_[2:0]xxxh | DDI 2: DP2_TX[P,N][3:0]                       | DDI 1: DP1_TX[P,N][3:0]                      |

#### **D0F0xE4\_x0[220,123:120]\_0000 Phy Compensation Control and Calibration Control I**

This register provides general control of various circuits that perform auto-calibration.

Table 69: Index Mapping for D0F0xE4\_x0[220,123:120]\_0000

| D0F0xE0[31:16] | D0F0xE0[15:0]                                               |
|----------------|-------------------------------------------------------------|
|                | 0000h                                                       |
| 0120h          | Gfx Links[7:0]: P_GFX_[T,R]X[P,N][7:0]                      |
| 0220h          | Gfx Links[15:8]: P_GFX_[T,R]X[P,N][15:8]                    |
| 0121h          | GPP Links: P_GPP_[T,R]X[P,N][7:0]                           |
| 0122h          | FCH ports: DDI 0: DP0_TX[P,N][3:0] & P_UMI_[T,R]X[P,N][3:0] |
| 0123h          | DDI 1: DP1_TX[P,N][3:0] & DDI 2: DP2_TX[P,N][3:0] &         |

| Bits  | Description                                                                                                                                                                                      |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:28 | Reserved.                                                                                                                                                                                        |
| 27:23 | <b>RttRawCal: receiver termination resistance (Rtt) raw calibration value.</b> Read-only. Reset: 0. This field provides the raw Rtt calibration value as determined by the compensation circuit. |

|       |                                                                                                                                                                                         |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 22:18 | <b>RonRawCal: transmitter resistance (Ron) raw calibration value.</b> Read-only. Reset: 0. This field provides the raw Ron calibration value as determined by the compensation circuit. |
| 17:0  | Reserved.                                                                                                                                                                               |

### **D0F0xE4\_x0[220,123:120]\_000[2:1] Phy Impedance Control**

Updates to these registers that result in a change to impedance may not take effect in the phy for up to 2 micro-seconds after the update to this register completes.

**Table 70: Recommended Ron settings**

|              |  | D0F0xE4_x0[220,123:120]_000[2:1] |          |
|--------------|--|----------------------------------|----------|
| Link Type    |  | RonCtl                           | RonIndex |
| Display Port |  | 0                                | 0        |
| HDMI™        |  | 3                                | 3        |
| DVI          |  | 0                                | 0        |
| PCIe         |  | 0                                | 0        |

**Table 71: Index Mapping for D0F0xE4\_x0[220,123:120]\_000[2:1]**

| D0F0xE0[31:16] | D0F0xE0[15:0]                                 |                                              |
|----------------|-----------------------------------------------|----------------------------------------------|
|                | 0002h                                         | 0001h                                        |
| 0120h          | Graphics port lower: P_GFX_[T,R]X[P,N][7:4]   | Graphics port lower: P_GFX_[T,R]X[P,N][3:0]  |
| 0220h          | Graphics port upper: P_GFX_[T,R]X[P,N][15:12] | Graphics port upper: P_GFX_[T,R]X[P,N][11:8] |
| 0121h          | GPP ports: P_GPP_[T,R]X[P,N][7:4]             | GPP ports: P_GPP_[T,R]X[P,N][3:0]            |
| 0122h          | DDI 0: DP0_TX[P,N][3:0]                       | FCH ports: P_UMI_[T,R]X[P,N][3:0]            |
| 0123h          | DDI 2: DP2_TX[P,N][3:0]                       | DDI 1: DP1_TX[P,N][3:0]                      |

| Bits      | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |      |            |      |                                                                                                             |      |                        |      |                                                                                                                                  |      |                                                                                                                              |      |                                                                                                                                                                               |           |           |
|-----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------------|------|-------------------------------------------------------------------------------------------------------------|------|------------------------|------|----------------------------------------------------------------------------------------------------------------------------------|------|------------------------------------------------------------------------------------------------------------------------------|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|-----------|
| 31:29     | <p><b>RttCtl: receiver termination resistance (Rtt) control.</b> Read-write. Reset: 0. Specifies how the receiver termination resistance value is calculated. All values between 00h and 1Fh are valid.</p> <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>000b</td><td>Rtt is as determined by the compensation circuit, <a href="#">D0F0xE4_x0[220,123:120]_0000</a>[RttRawCal].</td></tr> <tr> <td>001b</td><td>Rtt is (RttIndex - 3).</td></tr> <tr> <td>010b</td><td>Rtt is as specified by the difference: RttRawCal - RttIndex. If this results in a value that is less than 00h, then 00h is used.</td></tr> <tr> <td>011b</td><td>Rtt is as specified by the sum: RttRawCal + RttIndex. If this results in a value that is greater than 1Fh, then 1Fh is used.</td></tr> <tr> <td>100b</td><td>Enable only one tap of the Rtt resistor, as specified by RttIndex, and disable the base resistor that is normally always enabled. This is intended for testing purposes only.</td></tr> <tr> <td>111b-101b</td><td>Reserved.</td></tr> </table> <p>For all modes (except 100b), higher values reduce the resistance of Rtt and lower values increase the resistance of Rtt. See for more information about compensation. If RttCtl is programmed to either 011b or 100b, the value of RttRawCal + RttIndex must be less than or equal to 24.</p> | Bits | Definition | 000b | Rtt is as determined by the compensation circuit, <a href="#">D0F0xE4_x0[220,123:120]_0000</a> [RttRawCal]. | 001b | Rtt is (RttIndex - 3). | 010b | Rtt is as specified by the difference: RttRawCal - RttIndex. If this results in a value that is less than 00h, then 00h is used. | 011b | Rtt is as specified by the sum: RttRawCal + RttIndex. If this results in a value that is greater than 1Fh, then 1Fh is used. | 100b | Enable only one tap of the Rtt resistor, as specified by RttIndex, and disable the base resistor that is normally always enabled. This is intended for testing purposes only. | 111b-101b | Reserved. |
| Bits      | Definition                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |      |            |      |                                                                                                             |      |                        |      |                                                                                                                                  |      |                                                                                                                              |      |                                                                                                                                                                               |           |           |
| 000b      | Rtt is as determined by the compensation circuit, <a href="#">D0F0xE4_x0[220,123:120]_0000</a> [RttRawCal].                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |      |            |      |                                                                                                             |      |                        |      |                                                                                                                                  |      |                                                                                                                              |      |                                                                                                                                                                               |           |           |
| 001b      | Rtt is (RttIndex - 3).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |      |            |      |                                                                                                             |      |                        |      |                                                                                                                                  |      |                                                                                                                              |      |                                                                                                                                                                               |           |           |
| 010b      | Rtt is as specified by the difference: RttRawCal - RttIndex. If this results in a value that is less than 00h, then 00h is used.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |      |            |      |                                                                                                             |      |                        |      |                                                                                                                                  |      |                                                                                                                              |      |                                                                                                                                                                               |           |           |
| 011b      | Rtt is as specified by the sum: RttRawCal + RttIndex. If this results in a value that is greater than 1Fh, then 1Fh is used.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |      |            |      |                                                                                                             |      |                        |      |                                                                                                                                  |      |                                                                                                                              |      |                                                                                                                                                                               |           |           |
| 100b      | Enable only one tap of the Rtt resistor, as specified by RttIndex, and disable the base resistor that is normally always enabled. This is intended for testing purposes only.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |      |            |      |                                                                                                             |      |                        |      |                                                                                                                                  |      |                                                                                                                              |      |                                                                                                                                                                               |           |           |
| 111b-101b | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |      |            |      |                                                                                                             |      |                        |      |                                                                                                                                  |      |                                                                                                                              |      |                                                                                                                                                                               |           |           |
| 28:21     | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |      |            |      |                                                                                                             |      |                        |      |                                                                                                                                  |      |                                                                                                                              |      |                                                                                                                                                                               |           |           |
| 20:16     | <b>RttIndex: receiver termination resistance (Rtt) index.</b> Read-write. Reset: 0. See RttCtl.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |      |            |      |                                                                                                             |      |                        |      |                                                                                                                                  |      |                                                                                                                              |      |                                                                                                                                                                               |           |           |
| 15:13     | <p><b>RonCtl: transmitter resistance (Ron) control.</b> Read-write. Reset: 0. BIOS: This field specifies how the transmitter resistance value is calculated.</p> <table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>000b</td><td>Ron is as determined by the compensation circuit, <a href="#">D0F0xE4_x0[220,123:120]_0000</a>[RonRawCal].</td></tr> <tr> <td>001b</td><td>Ron is (RonIndex - 3).</td></tr> <tr> <td>010b</td><td>Ron is as specified by the difference: RonRawCal - RonIndex. If this results in a value that is less than 00h, then 00h is used.</td></tr> <tr> <td>011b</td><td>Ron is as specified by the sum: RonRawCal + RonIndex. If this results in a value that is greater than 1Fh, then 1Fh is used.</td></tr> <tr> <td>100b</td><td>Enable only one tap of the Ron resistor, as specified by RonIndex, and disable the base resistor that is normally always enabled. This is intended for testing purposes only.</td></tr> <tr> <td>111b-101b</td><td>Reserved.</td></tr> </table> <p>For all modes (except 100b), higher values reduce the resistance of Ron and lower values increase the resistance of Ron. If RonCtl is programmed to either 011b or 100b, the value of RonRawCal + RonIndex must be less than or equal to 23.</p>                                                                                         | Bits | Definition | 000b | Ron is as determined by the compensation circuit, <a href="#">D0F0xE4_x0[220,123:120]_0000</a> [RonRawCal]. | 001b | Ron is (RonIndex - 3). | 010b | Ron is as specified by the difference: RonRawCal - RonIndex. If this results in a value that is less than 00h, then 00h is used. | 011b | Ron is as specified by the sum: RonRawCal + RonIndex. If this results in a value that is greater than 1Fh, then 1Fh is used. | 100b | Enable only one tap of the Ron resistor, as specified by RonIndex, and disable the base resistor that is normally always enabled. This is intended for testing purposes only. | 111b-101b | Reserved. |
| Bits      | Definition                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |      |            |      |                                                                                                             |      |                        |      |                                                                                                                                  |      |                                                                                                                              |      |                                                                                                                                                                               |           |           |
| 000b      | Ron is as determined by the compensation circuit, <a href="#">D0F0xE4_x0[220,123:120]_0000</a> [RonRawCal].                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |      |            |      |                                                                                                             |      |                        |      |                                                                                                                                  |      |                                                                                                                              |      |                                                                                                                                                                               |           |           |
| 001b      | Ron is (RonIndex - 3).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |      |            |      |                                                                                                             |      |                        |      |                                                                                                                                  |      |                                                                                                                              |      |                                                                                                                                                                               |           |           |
| 010b      | Ron is as specified by the difference: RonRawCal - RonIndex. If this results in a value that is less than 00h, then 00h is used.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |      |            |      |                                                                                                             |      |                        |      |                                                                                                                                  |      |                                                                                                                              |      |                                                                                                                                                                               |           |           |
| 011b      | Ron is as specified by the sum: RonRawCal + RonIndex. If this results in a value that is greater than 1Fh, then 1Fh is used.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |      |            |      |                                                                                                             |      |                        |      |                                                                                                                                  |      |                                                                                                                              |      |                                                                                                                                                                               |           |           |
| 100b      | Enable only one tap of the Ron resistor, as specified by RonIndex, and disable the base resistor that is normally always enabled. This is intended for testing purposes only.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |      |            |      |                                                                                                             |      |                        |      |                                                                                                                                  |      |                                                                                                                              |      |                                                                                                                                                                               |           |           |
| 111b-101b | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |      |            |      |                                                                                                             |      |                        |      |                                                                                                                                  |      |                                                                                                                              |      |                                                                                                                                                                               |           |           |
| 12:5      | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |      |            |      |                                                                                                             |      |                        |      |                                                                                                                                  |      |                                                                                                                              |      |                                                                                                                                                                               |           |           |
| 4:0       | <b>RonIndex: transmitter resistance (Ron) index.</b> Read-write. Reset: 0. BIOS: See RonCtl.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |      |            |      |                                                                                                             |      |                        |      |                                                                                                                                  |      |                                                                                                                              |      |                                                                                                                                                                               |           |           |

#### **[D0F0xE4\\_x0\[220,123:120\]\\_000\[C:B\]](#) Phy Serial Bus Packet Control**

This register provides control to enable or disable various fields contained in the phy serial bus primary control

packet, the margining packet and the miscellaneous control packet.

Table 72: [Index Mapping](#) for [D0F0xE4\\_x0\[220,123:120\]\\_000\[C:B\]](#)

| D0F0xE0[31:16] | D0F0xE0[15:0]                                 |                                              |
|----------------|-----------------------------------------------|----------------------------------------------|
|                | 000Ch                                         | 000Bh                                        |
| 0120h          | Graphics port lower: P_GFX_[T,R]X[P,N][7:4]   | Graphics port lower: P_GFX_[T,R]X[P,N][3:0]  |
| 0220h          | Graphics port upper: P_GFX_[T,R]X[P,N][15:12] | Graphics port upper: P_GFX_[T,R]X[P,N][11:8] |
| 0121h          | GPP ports: P_GPP_[T,R]X[P,N][7:4]             | GPP ports: P_GPP_[T,R]X[P,N][3:0]            |
| 0122h          | DDI 0: DP0_TX[P,N][3:0]                       | FCH ports: P_UMI_[T,R]X[P,N][3:0]            |
| 0123h          | DDI 2: DP2_TX[P,N][3:0]                       | DDI 1: DP1_TX[P,N][3:0]                      |

| Bits  | Description                                                                                                                                                               |
|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:18 | Reserved.                                                                                                                                                                 |
| 17    | <b>TxCoeffPktSbiEn</b> . Read-write. Reset: 1. 1=Enables the transmitter coefficient packet used for controlling transmitter the transmitter coefficient.                 |
| 16    | <b>RxEqPktSbiEn</b> . Read-write. Reset: 1. 1=Enables the receiver equalization packet used for controlling receiver equalization.                                        |
| 15    | <b>PllCmpPktSbiEn</b> . Read-write. Reset: 1. 1=Enables the serial bus PLL component packet used for controlling PLL features such as mode of operation and power states. |
| 14    | <b>MargPktSbiEn</b> . Read-write. Reset: 1. 1=Enables the serial bus margining update packet used for controlling PCIe transmit margining test.                           |
| 13:9  | Reserved.                                                                                                                                                                 |
| 8     | <b>EiDetSbiEn</b> . Read-write. Reset: 1. 1=Enables the electrical idle detector control field in the primary control packet.                                             |
| 7     | <b>IncoherentClkSbiEn</b> . Read-write. Reset: 1. 1=Enables the incoherent clock control field in the primary control packet.                                             |
| 6     | <b>SkipBitSbiEn</b> . Read-write. Reset: 1. 1=Enables the skip bit control field in the primary control packet.                                                           |
| 5     | <b>OffsetCancelSbiEn</b> . Read-write. Reset: 1. 1=Enables the offset cancellation control field in the primary control packet.                                           |
| 4     | <b>DllLockSbiEn</b> . Read-write. Reset: 1. 1=Enables the DLL lock control field in the primary control packet.                                                           |
| 3     | <b>FreqDivSbiEn</b> . Read-write. Reset: 1. 1=Enables the frequency divider control field in the primary control packet.                                                  |
| 2     | <b>PcieModeSbiEn</b> . Read-write. Reset: 1. 1=Enables the phy mode control field in the primary control packet.                                                          |
| 1     | <b>RxPwrSbiEn</b> . Read-write. Reset: 1. 1=Enables the Rx power state control field in the primary control packet.                                                       |
| 0     | <b>TxPwrSbiEn</b> . Read-write. Reset: 1. 1=Enables the Tx power state control field in the primary control packet.                                                       |

### 3.3.2.2 Phy Receiver Lane Control Registers

Each receiver lane has a group of registers for controlling the operation of the lane. The mapping from address

register to receiver lane is shown in Table 73. Multiple receiver lanes may be written at the sametime using per nibble and per byte broadcast write addresses. The mapping from broadcast address to receiver lanes is shown in Table 74.

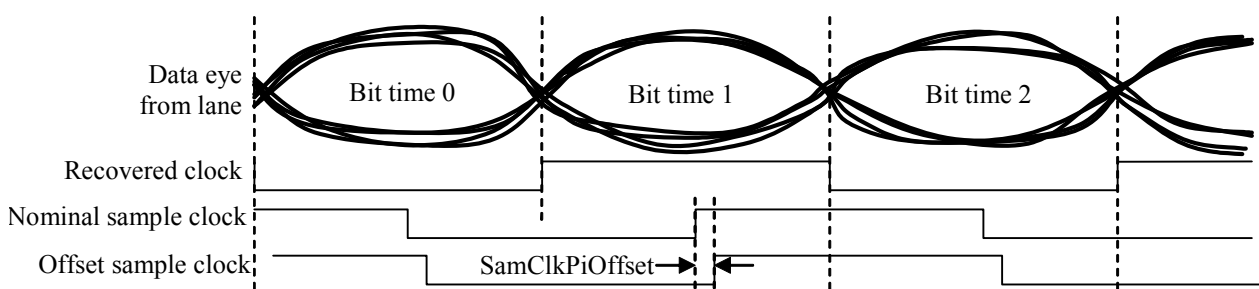
**Table 73: Phy per receiver lane register addresses**

| Pin Group | D0F0xE0[31:16] | D0F0xE0[15:0] |           |           |           |           |           |          |          |
|-----------|----------------|---------------|-----------|-----------|-----------|-----------|-----------|----------|----------|
|           |                | 438xh         | 430xh     | 428xh     | 420xh     | 418xh     | 410xh     | 408xh    | 400xh    |
| P_GFX_    | 0120h          | RX[P,N]7      | RX[P,N]6  | RX[P,N]5  | RX[P,N]4  | RX[P,N]3  | RX[P,N]2  | RX[P,N]1 | RX[P,N]0 |
| P_GFX_    | 0220h          | RX[P,N]15     | RX[P,N]14 | RX[P,N]13 | RX[P,N]12 | RX[P,N]11 | RX[P,N]10 | RX[P,N]9 | RX[P,N]8 |
| P_GPP_    | 0121h          | RX[P,N]7      | RX[P,N]6  | RX[P,N]5  | RX[P,N]4  | RX[P,N]3  | RX[P,N]2  | RX[P,N]1 | RX[P,N]0 |
| P_UMI_    | 0122h          | -             | -         | -         | -         | RX[P,N]3  | RX[P,N]2  | RX[P,N]1 | RX[P,N]0 |
| P_DP1_    | 0123h          | -             | -         | -         | -         | -         | -         | -        | -        |
| P_DP2_    | 0123h          | -             | -         | -         | -         | -         | -         | -        | -        |

**Table 74: Phy receiver broadcast register addresses**

| D0F0xE0[31:16] | D0F0xE0[15:0]        |                     |                     |
|----------------|----------------------|---------------------|---------------------|
|                | 57[1,0]xh            | 56[1,0]xh           | 50[1,0]xh           |
| 0120h          | P_GFX_RX[P,N][7:4]   | P_GFX_RX[P,N][3:0]  | P_GFX_RX[P,N][7:0]  |
| 0220h          | P_GFX_RX[P,N][15:12] | P_GFX_RX[P,N][11:8] | P_GFX_RX[P,N][15:8] |
| 0121h          | P_GPP_RX[P,N][7:4]   | P_GPP_RX[P,N][3:0]  | P_GPP_RX[P,N][7:0]  |
| 0122h          | -                    | P_UMI_RX[P,N][3:0]  | P_UMI_RX[P,N][3:0]  |
| 0123h          | -                    | -                   | -                   |

#### D0F0xE4\_x0[220,123:120]\_5:4[7:6,3:0][8,0]2 Phy Receiver Phase Loop Filter Control



**Figure 9: Phy recovered clock and sample clock**

When the link is in a mode that relies on dynamic phase alignment (automatic sample-clock correction), then the processor generates a recovered clock for each lane based on transitions in the lane. The ideal recovered clock transitions at exactly the same time as the transitions in the lane. Phase detection logic detects if the recovered clock transitions before or after the lane transition. The digital loop filter (DLF) is logic that adjusts the phase of the recovered clock such that its transitions match the transition time of the lane as much as possible. The DLF counts the number of times the lane transitions before the recovered clock versus after to determine whether the recovered clock phase requires adjustment. The DLF uses an 8-bit counter, called the loop filter counter (LFC) for this purpose. The LFC controls are included in this register. They specify DLF behavior as follows:

- LfcMax is programmed to be greater than LfcMin.



- The LFC is initialized to LfcMin.
- The LFC is updated periodically. The logic keeps a tally of the number of lane transitions occurring before and after the recovered clock transition within each update period.
- To start, if there is a net lane transition occurs after the recovered clock transition within the update period, the LFC is incremented by the net value; on the other hand, if there is a net lane transition occurs before the recovered clock transition, the LFC is decremented. However, if the LFC is ever decremented while it is zero, these rules are reversed (and the LFC is incremented instead). Thus, if there is a phase correction needed, the LFC trends either upward or downward; if it trends downward, it hits zero and then trends upward again.
- If the LFC reaches LfcMax value, then (1) the phase of the recovered clock is adjusted in the appropriate direction, (2) the LFC is set to the LfcMin value.

The LfcMin and LfcMax fields are designed to improve the stability of the recovered clock phase while improving the response time for multiple phase updates in the same direction. For example, if the recovered clock phase needs several adjustments in the same direction, then the LFC increments until it hits LfcMax value and then be set to LfcMin (and trigger a phase adjustment); then it would increment to LfcMax value again to trigger the next phase adjustment. If, however, the next phase adjustment needs to be in the opposite direction, the LFC would decrement to zero, change direction, and then increment up to LfcMax again. In this way, phase adjustments in the same direction occur more quickly than phase adjustments in the opposite direction of the prior phase adjustment.

The nominal sample clock is offset by 90 degrees from the *recovered clock*.

Table 75: Index Mapping for D0F0xE4\_x0[220:120]\_[5:4][7:6,3:0][8,0]2

| Pin Group | D0F0xE0[31:16] | D0F0xE0[15:0] |           |           |           |           |           |          |          |
|-----------|----------------|---------------|-----------|-----------|-----------|-----------|-----------|----------|----------|
|           |                | 4382h         | 4302h     | 4282h     | 4202h     | 4182h     | 4102h     | 4082h    | 4002h    |
| P_GFX_    | 0120h          | RX[P,N]7      | RX[P,N]6  | RX[P,N]5  | RX[P,N]4  | RX[P,N]3  | RX[P,N]2  | RX[P,N]1 | RX[P,N]0 |
| P_GFX_    | 0220h          | RX[P,N]15     | RX[P,N]14 | RX[P,N]13 | RX[P,N]12 | RX[P,N]11 | RX[P,N]10 | RX[P,N]9 | RX[P,N]8 |
| P_GPP_    | 0121h          | RX[P,N]7      | RX[P,N]6  | RX[P,N]5  | RX[P,N]4  | RX[P,N]3  | RX[P,N]2  | RX[P,N]1 | RX[P,N]0 |
| P_UMI_    | 0122h          | -             | -         | -         | -         | RX[P,N]3  | RX[P,N]2  | RX[P,N]1 | RX[P,N]0 |
| P_DP1_    | 0123h          | -             | -         | -         | -         | -         | -         | -        | -        |
| P_DP2_    | 0123h          | -             | -         | -         | -         | -         | -         | -        | -        |

Table 76: Broadcast Mapping for D0F0xE4\_x0[220:120]\_[5:4][7:6,3:0][8,0]2

| D0F0xE0[31:16] | D0F0xE0[15:0]              |                            |                            |
|----------------|----------------------------|----------------------------|----------------------------|
|                | 5702h                      | 5602h                      | 5002h                      |
| 0120h          | D0F0xE4_x0120_4[3:2][8,0]2 | D0F0xE4_x0120_4[1:0][8,0]2 | D0F0xE4_x0120_4[3:0][8,0]2 |
| 0220h          | D0F0xE4_x0220_4[3:2][8,0]2 | D0F0xE4_x0220_4[1:0][8,0]2 | D0F0xE4_x0220_4[3:0][8,0]2 |
| 0121h          | D0F0xE4_x0121_4[3:2][8,0]2 | D0F0xE4_x0121_4[1:0][8,0]2 | D0F0xE4_x0121_4[3:0][8,0]2 |
| 0122h          | D0F0xE4_x0122_4[3:2][8,0]2 | D0F0xE4_x0122_4[1:0][8,0]2 | D0F0xE4_x0122_4[3:0][8,0]2 |
| 0123h          | -                          | -                          | -                          |

| Bits  | Description                                                                          |
|-------|--------------------------------------------------------------------------------------|
| 31:30 | Reserved.                                                                            |
| 29:22 | <b>LfcMax: loop filter counter maximum value.</b> Read-write. Reset: 08h. BIOS: 08h. |

|       |                                                                                      |
|-------|--------------------------------------------------------------------------------------|
| 21:14 | <b>LfcMin: loop filter counter minimum value.</b> Read-write. Reset: 00h. BIOS: 00h. |
| 13:0  | Reserved.                                                                            |

### D0F0xE4\_x0[220,123:120]\_[5:4][7:6,3:0][8,0]5 Phy Receiver Timing Margin Test

The built in jitter injection test mode is useful for checking the clock data recovery tracking bandwidth of the receiver. By forcing the sample clock to move from the lock position by a controlled amount and then observing the time it takes to recover, the tracking rate and bandwidth can be estimated. This register provides the control of the test mode.

The jitter injection test mode works as follows.

- The circuit is clocked by a jitter injection clock derived from dividing the link forwarded clock by 2.5; for example, if the link speed is 5.2GT/s and the link forwarded clock frequency is 2.6GHz, the jitter injection clock frequency becomes 1.04GHz.
- There are 2 phases, the on phase and the off phase. It starts with the on phase once the test mode is enabled.
- During the on phase, at every tick of jitter injection clock, the sample clock is moved away from the nominal lock position by  $1/96 \cdot UI$ .
- The direction of adjustment is specified by JitterInjDir.
- The on phase adjustment continues for a number of times as specified by JitterInjOnCnt.
- Then the adjustment turns off for a duration specified by {JitterInjOffCnt, JitterInjOnCnt} \* jitter injection clock period, this is known as the off phase. During this time, clock data recovery resumes to try to adjust the position of the sample clock back to the center of the data eye.
- The off phase is followed by the on phase again. The process continues to alternate between the on phase and the off phase until the jitter injection test mode is disabled.

In addition, the JitterInjHold bit may be set to inject a hold state at the end of the on phase. This stops clock data recovery from resuming after the on phase, hence holding the sample clock at its last adjusted position until the JitterInjHold bit is cleared. This test mode may be useful for margining the width of the input data eye.

This margining mechanism is not characterized for precision jitter adjustments or measurements.

Table 77: Index Mapping for D0F0xE4\_x0[220,123:120]\_[5:4][7:6,3:0][8,0]5

| Pin Group | D0F0xE0[31:16] | D0F0xE0[15:0] |           |           |           |           |           |          |          |
|-----------|----------------|---------------|-----------|-----------|-----------|-----------|-----------|----------|----------|
|           |                | 4385h         | 4305h     | 4285h     | 4205h     | 4185h     | 4105h     | 4085h    | 4005h    |
| P_GFX_    | 0120h          | RX[P,N]7      | RX[P,N]6  | RX[P,N]5  | RX[P,N]4  | RX[P,N]3  | RX[P,N]2  | RX[P,N]1 | RX[P,N]0 |
| P_GFX_    | 0220h          | RX[P,N]15     | RX[P,N]14 | RX[P,N]13 | RX[P,N]12 | RX[P,N]11 | RX[P,N]10 | RX[P,N]9 | RX[P,N]8 |
| P_GPP_    | 0121h          | RX[P,N]7      | RX[P,N]6  | RX[P,N]5  | RX[P,N]4  | RX[P,N]3  | RX[P,N]2  | RX[P,N]1 | RX[P,N]0 |
| P_UMI_    | 0122h          | -             | -         | -         | -         | RX[P,N]3  | RX[P,N]2  | RX[P,N]1 | RX[P,N]0 |
| P_DP1_    | 0123h          | -             | -         | -         | -         | -         | -         | -        | -        |
| P_DP2_    | 0123h          | -             | -         | -         | -         | -         | -         | -        | -        |

Table 78: Broadcast Mapping for D0F0xE4\_x0[220,123:120]\_[5:4][7:6,3:0][8,0]5

| D0F0xE0[31:16] | D0F0xE0[15:0]              |                            |                            |
|----------------|----------------------------|----------------------------|----------------------------|
|                | 5705h                      | 5605h                      | 5005h                      |
| 0120h          | D0F0xE4_x0120_4[3:2][8,0]5 | D0F0xE4_x0120_4[1:0][8,0]5 | D0F0xE4_x0120_4[3:0][8,0]5 |
| 0220h          | D0F0xE4_x0220_4[3:2][8,0]5 | D0F0xE4_x0220_4[1:0][8,0]5 | D0F0xE4_x0220_4[3:0][8,0]5 |
| 0121h          | D0F0xE4_x0121_4[3:2][8,0]5 | D0F0xE4_x0121_4[1:0][8,0]5 | D0F0xE4_x0121_4[3:0][8,0]5 |

**Table 78: Broadcast Mapping for D0F0xE4\_x0[220,123:120]\_[5:4][7:6,3:0][8,0]5**

|       |                            |                            |                            |
|-------|----------------------------|----------------------------|----------------------------|
| 0122h | D0F0xE4_x0122_4[3:2][8,0]5 | D0F0xE4_x0122_4[1:0][8,0]5 | D0F0xE4_x0122_4[3:0][8,0]5 |
| 0123h | -                          | -                          | -                          |

| Bits  | Description                                                                                                                                                                                                                                                                             |     |            |   |                                              |   |                                             |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|------------|---|----------------------------------------------|---|---------------------------------------------|
| 31    | Reserved.                                                                                                                                                                                                                                                                               |     |            |   |                                              |   |                                             |
| 30    | <b>JitterInjEn: jitter injection enable.</b> Read-write. Reset: 0. 1=Jitter injection test mode is enabled.                                                                                                                                                                             |     |            |   |                                              |   |                                             |
| 29    | <b>JitterInjDir: jitter injection direction.</b> Read-write. Reset: 0.<br><table> <tr> <th>Bit</th><th>Definition</th></tr> <tr> <td>0</td><td>Move clock before the nominal lock position.</td></tr> <tr> <td>1</td><td>Move clock after the nominal lock position.</td></tr> </table> | Bit | Definition | 0 | Move clock before the nominal lock position. | 1 | Move clock after the nominal lock position. |
| Bit   | Definition                                                                                                                                                                                                                                                                              |     |            |   |                                              |   |                                             |
| 0     | Move clock before the nominal lock position.                                                                                                                                                                                                                                            |     |            |   |                                              |   |                                             |
| 1     | Move clock after the nominal lock position.                                                                                                                                                                                                                                             |     |            |   |                                              |   |                                             |
| 28:23 | <b>JitterInjOnCnt: jitter injection on count.</b> Read-write. Reset: 0.                                                                                                                                                                                                                 |     |            |   |                                              |   |                                             |
| 22:16 | Reserved.                                                                                                                                                                                                                                                                               |     |            |   |                                              |   |                                             |
| 15:10 | <b>JitterInjOffCnt: jitter injection off count.</b> Read-write. Reset: 0. The jitter injection off time count is a 12bit code, this field specifies the most significant 6 bits. The least significant 6 bits are the same as JitterInjOnCnt.                                           |     |            |   |                                              |   |                                             |
| 9     | <b>JitterInjHold: jitter injection hold.</b> Read-write. Reset: 0. 1=Jitter injection hold is enabled.                                                                                                                                                                                  |     |            |   |                                              |   |                                             |
| 8:0   | Reserved.                                                                                                                                                                                                                                                                               |     |            |   |                                              |   |                                             |

#### D0F0xE4\_x0[220,123:120]\_[5:4][7:6,3:0][8,0]6 Phy Receiver DFE and DFR Control

The processor supports decision feedback restore (DFR), a function that enables on-chip AC coupling on the receiver path, to improve the receiver's ability to operate over a longer channel. In this mode, the receiver on the processor must be programmed with the expected peak single-ended DC voltage level over the single-ended DC common mode voltage level, as seen by the receiver, when a static 1 or 0 is driven. For example, without deemphasis at nominal supply voltage of 1.2V, the peak single ended voltage is expected to be 300mV ideally above the single ended DC common mode voltage level. The value is dependent on the deemphasis setting of the transmitter on the other end of the channel.

**Table 79: BIOS Recommendations for D0F0xE4\_x0[220,123:120]\_[5:4][7:6,3:0][8,0]6[VdcDac]**

| Far-device deemphasis setting | VdcDac |
|-------------------------------|--------|
| No deemphasis                 | 4Dh    |
| -2dB postcursor               | 3Dh    |
| -3dB postcursor               | 36h    |
| -5dB postcursor               | 2Bh    |
| -6dB postcursor               | 27h    |
| -7dB postcursor               | 22h    |
| -8dB postcursor               | 1Fh    |
| -9dB postcursor               | 1Bh    |
| -11dB postcursor              | 16h    |

Decision feedback equalization (DFE) can be enabled to enhance link operation. Once enabled, the receiver uses the logic level of the previous data bit to adjust the voltage threshold of the sampler in the direction that causes the sampler to switch sooner when the data bit transitions to the opposite logic level for the next bit. The control and DFE voltage level are included in this register.

Table 80: Index Mapping for D0F0xE4\_x0[220,123:120]\_[5:4][7:6,3:0][8,0]6

| Pin Group | D0F0xE0[31:16] | D0F0xE0[15:0] |           |           |           |           |           |          |          |
|-----------|----------------|---------------|-----------|-----------|-----------|-----------|-----------|----------|----------|
|           |                | 4386h         | 4306h     | 4286h     | 4206h     | 4186h     | 4106h     | 4086h    | 4006h    |
| P_GFX_    | 0120h          | RX[P,N]7      | RX[P,N]6  | RX[P,N]5  | RX[P,N]4  | RX[P,N]3  | RX[P,N]2  | RX[P,N]1 | RX[P,N]0 |
| P_GFX_    | 0220h          | RX[P,N]15     | RX[P,N]14 | RX[P,N]13 | RX[P,N]12 | RX[P,N]11 | RX[P,N]10 | RX[P,N]9 | RX[P,N]8 |
| P_GPP_    | 0121h          | RX[P,N]7      | RX[P,N]6  | RX[P,N]5  | RX[P,N]4  | RX[P,N]3  | RX[P,N]2  | RX[P,N]1 | RX[P,N]0 |
| P_UMI_    | 0122h          | -             | -         | -         | -         | RX[P,N]3  | RX[P,N]2  | RX[P,N]1 | RX[P,N]0 |
| P_DP1_    | 0123h          | -             | -         | -         | -         | -         | -         | -        | -        |
| P_DP2_    | 0123h          | -             | -         | -         | -         | -         | -         | -        | -        |

Table 81: Broadcast Mapping for D0F0xE4\_x0[220,123:120]\_[5:4][7:6,3:0][8,0]6

| D0F0xE0[31:16] | D0F0xE0[15:0]              |                            |                            |
|----------------|----------------------------|----------------------------|----------------------------|
|                | 5706h                      | 5606h                      | 5006h                      |
| 0120h          | D0F0xE4_x0120_4[3:2][8,0]6 | D0F0xE4_x0120_4[1:0][8,0]6 | D0F0xE4_x0120_4[3:0][8,0]6 |
| 0220h          | D0F0xE4_x0220_4[3:2][8,0]6 | D0F0xE4_x0220_4[1:0][8,0]6 | D0F0xE4_x0220_4[3:0][8,0]6 |
| 0121h          | D0F0xE4_x0121_4[3:2][8,0]6 | D0F0xE4_x0121_4[1:0][8,0]6 | D0F0xE4_x0121_4[3:0][8,0]6 |
| 0122h          | D0F0xE4_x0122_4[3:2][8,0]6 | D0F0xE4_x0122_4[1:0][8,0]6 | D0F0xE4_x0122_4[3:0][8,0]6 |
| 0123h          | -                          | -                          | -                          |

| Bits | Description                                                                                                                                                                                                                                                                                                                                                                                                                         |      |                             |      |            |     |                          |     |                            |     |                         |     |                             |
|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-----------------------------|------|------------|-----|--------------------------|-----|----------------------------|-----|-------------------------|-----|-----------------------------|
| 31:9 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                           |      |                             |      |            |     |                          |     |                            |     |                         |     |                             |
| 8    | <b>DfeEn: DFE enable.</b> Read-write. Reset: 0. 1=Decision feedback equalization is enabled.                                                                                                                                                                                                                                                                                                                                        |      |                             |      |            |     |                          |     |                            |     |                         |     |                             |
| 7    | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                           |      |                             |      |            |     |                          |     |                            |     |                         |     |                             |
| 6:5  | <b>DfeVoltage: DFE offset voltage level.</b> Read-write. Reset: 0. This field specifies the magnitude of the DFE offset voltage. <table><tr><th>Bits</th><th>Definition</th><th>Bits</th><th>Definition</th></tr><tr><td>00b</td><td>DFE offset voltage=25mV.</td><td>10b</td><td>DFE offset voltage=12.5mV.</td></tr><tr><td>01b</td><td>DFE offset voltage=0mV.</td><td>11b</td><td>DFE offset voltage=31.25mV.</td></tr></table> | Bits | Definition                  | Bits | Definition | 00b | DFE offset voltage=25mV. | 10b | DFE offset voltage=12.5mV. | 01b | DFE offset voltage=0mV. | 11b | DFE offset voltage=31.25mV. |
| Bits | Definition                                                                                                                                                                                                                                                                                                                                                                                                                          | Bits | Definition                  |      |            |     |                          |     |                            |     |                         |     |                             |
| 00b  | DFE offset voltage=25mV.                                                                                                                                                                                                                                                                                                                                                                                                            | 10b  | DFE offset voltage=12.5mV.  |      |            |     |                          |     |                            |     |                         |     |                             |
| 01b  | DFE offset voltage=0mV.                                                                                                                                                                                                                                                                                                                                                                                                             | 11b  | DFE offset voltage=31.25mV. |      |            |     |                          |     |                            |     |                         |     |                             |
| 4:0  | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                           |      |                             |      |            |     |                          |     |                            |     |                         |     |                             |

**D0F0xE4\_x0[220,123:120]\_[5:4][7:6,3:0][8,0]A Phy DLL Test and Control 3**

Table 82: Index Mapping for D0F0xE4\_x0[220,123:120]\_[5:4][7:6,3:0][8,0]A

| Pin Group | D0F0xE0[31:16] | D0F0xE0[15:0] |           |           |           |           |           |          |          |
|-----------|----------------|---------------|-----------|-----------|-----------|-----------|-----------|----------|----------|
|           |                | 438Ah         | 430Ah     | 428Ah     | 420Ah     | 418Ah     | 410Ah     | 408Ah    | 400Ah    |
| P_GFX_    | 0120h          | RX[P,N]7      | RX[P,N]6  | RX[P,N]5  | RX[P,N]4  | RX[P,N]3  | RX[P,N]2  | RX[P,N]1 | RX[P,N]0 |
| P_GFX_    | 0220h          | RX[P,N]15     | RX[P,N]14 | RX[P,N]13 | RX[P,N]12 | RX[P,N]11 | RX[P,N]10 | RX[P,N]9 | RX[P,N]8 |
| P_GPP_    | 0121h          | RX[P,N]7      | RX[P,N]6  | RX[P,N]5  | RX[P,N]4  | RX[P,N]3  | RX[P,N]2  | RX[P,N]1 | RX[P,N]0 |
| P_UMI_    | 0122h          | -             | -         | -         | -         | RX[P,N]3  | RX[P,N]2  | RX[P,N]1 | RX[P,N]0 |
| P_DP1_    | 0123h          | -             | -         | -         | -         | -         | -         | -        | -        |
| P_DP2_    | 0123h          | -             | -         | -         | -         | -         | -         | -        | -        |

**Table 83: Broadcast Mapping for D0F0xE4\_x0[220,123:120]\_[5:4][7:6,3:0][8,0]A**

| D0F0xE0[31:16] | D0F0xE0[15:0]              |                            |                            |
|----------------|----------------------------|----------------------------|----------------------------|
|                | 570Ah                      | 560Ah                      | 500Ah                      |
| 0120h          | D0F0xE4_x0120_4[3:2][8,0]A | D0F0xE4_x0120_4[1:0][8,0]A | D0F0xE4_x0120_4[3:0][8,0]A |
| 0220h          | D0F0xE4_x0220_4[3:2][8,0]A | D0F0xE4_x0220_4[1:0][8,0]A | D0F0xE4_x0220_4[3:0][8,0]A |
| 0121h          | D0F0xE4_x0121_4[3:2][8,0]A | D0F0xE4_x0121_4[1:0][8,0]A | D0F0xE4_x0121_4[3:0][8,0]A |
| 0122h          | D0F0xE4_x0122_4[3:2][8,0]A | D0F0xE4_x0122_4[1:0][8,0]A | D0F0xE4_x0122_4[3:0][8,0]A |
| 0123h          | -                          | -                          | -                          |

| Bits        | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |             |                   |             |                   |     |               |     |              |     |                |     |                 |
|-------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|-------------------|-------------|-------------------|-----|---------------|-----|--------------|-----|----------------|-----|-----------------|
| 31:18       | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |             |                   |             |                   |     |               |     |              |     |                |     |                 |
| 17          | <b>DllLockFastModeEn: DLL lock fast mode enable.</b> Read-write. Reset: 0. 1=Enables DLL lock fast mode. 0=DLL lock operates at standard speed.                                                                                                                                                                                                                                                                                                                                                |             |                   |             |                   |     |               |     |              |     |                |     |                 |
| 16:15       | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |             |                   |             |                   |     |               |     |              |     |                |     |                 |
| 14:13       | <b>AnalogWaitTime: analog wait time to turn on DLL.</b> Read-write. Reset: 0. The turning on of the DLL circuit after cold reset is delayed by a timer specified by this field. The encodings are as follows: <table><tr><td><u>Bits</u></td><td><u>Definition</u></td><td><u>Bits</u></td><td><u>Definition</u></td></tr><tr><td>00b</td><td>Delay=1.25us.</td><td>10b</td><td>Delay=2.5us.</td></tr><tr><td>01b</td><td>Delay=0.625us.</td><td>11b</td><td>Delay=0.3125us.</td></tr></table> | <u>Bits</u> | <u>Definition</u> | <u>Bits</u> | <u>Definition</u> | 00b | Delay=1.25us. | 10b | Delay=2.5us. | 01b | Delay=0.625us. | 11b | Delay=0.3125us. |
| <u>Bits</u> | <u>Definition</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <u>Bits</u> | <u>Definition</u> |             |                   |     |               |     |              |     |                |     |                 |
| 00b         | Delay=1.25us.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 10b         | Delay=2.5us.      |             |                   |     |               |     |              |     |                |     |                 |
| 01b         | Delay=0.625us.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 11b         | Delay=0.3125us.   |             |                   |     |               |     |              |     |                |     |                 |
| 12:0        | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |             |                   |             |                   |     |               |     |              |     |                |     |                 |

### 3.3.2.3 Phy Transmitter Lane Control Registers

Each transmitter lane has a group of registers for controlling the operation of the lane. The mapping from address register to transmitter lane is shown in Table 84. Multiple transmitter lanes may be written at the same time using per nibble and per byte broadcast write addresses. The mapping from broadcast address to transmitter lanes is shown in Table 85.

**Table 84: Phy per transmitter lane register addresses**

| Pin Group | D0F0xE0[31:16] | D0F0xE0[15:0] |           |           |           |           |           |          |          |
|-----------|----------------|---------------|-----------|-----------|-----------|-----------|-----------|----------|----------|
|           |                | 638xh         | 630xh     | 628xh     | 620xh     | 618xh     | 610xh     | 608xh    | 600xh    |
| P_GFX_    | 0120h          | TX[P,N]7      | TX[P,N]6  | TX[P,N]5  | TX[P,N]4  | TX[P,N]3  | TX[P,N]2  | TX[P,N]1 | TX[P,N]0 |
| P_GFX_    | 0220h          | TX[P,N]15     | TX[P,N]14 | TX[P,N]13 | TX[P,N]12 | TX[P,N]11 | TX[P,N]10 | TX[P,N]9 | TX[P,N]8 |
| P_GPP_    | 0121h          | TX[P,N]7      | TX[P,N]6  | TX[P,N]5  | TX[P,N]4  | TX[P,N]3  | TX[P,N]2  | TX[P,N]1 | TX[P,N]0 |
| P_UMI_    | 0122h          | -             | -         | -         | -         | TX[P,N]3  | TX[P,N]2  | TX[P,N]1 | TX[P,N]0 |
| P_DP0_    | 0122h          | TX[P,N]3      | TX[P,N]2  | TX[P,N]1  | TX[P,N]0  | -         | -         | -        | -        |
| P_DP1_    | 0123h          | -             | -         | -         | -         | TX[P,N]3  | TX[P,N]2  | TX[P,N]1 | TX[P,N]0 |
| P_DP2_    | 0123h          | TX[P,N]3      | TX[P,N]2  | TX[P,N]1  | TX[P,N]0  | -         | -         | -        | -        |

**Table 85: Phy transmitter broadcast register addresses**

| D0F0xE0[31:16] | D0F0xE0[15:0] |           |           |
|----------------|---------------|-----------|-----------|
|                | 77[1,0]xh     | 76[1,0]xh | 70[1,0]xh |

**Table 85: Phy transmitter broadcast register addresses**

|       |                      |                     |                        |
|-------|----------------------|---------------------|------------------------|
| 0120h | P_GFX_TX[P,N][7:4]   | P_GFX_TX[P,N][3:0]  | P_GFX_TX[P,N][7:0]     |
| 0220h | P_GFX_TX[P,N][15:12] | P_GFX_TX[P,N][11:8] | P_GFX_TX[P,N][15:8]    |
| 0121h | P_GPP_TX[P,N][7:4]   | P_GPP_TX[P,N][3:0]  | P_GPP_TX[P,N][7:0]     |
| 0122h | P_DP0_TX[P,N][3:0]   | P_UMI_TX[P,N][3:0]  | P_UMI_TX[P,N][3:0]     |
| 0123h | P_DP2_TX[P,N][3:0]   | P_DP1_TX[P,N][3:0]  | P_DP[2:1]_TX[P,N][3:0] |

**D0F0xE4\_x0[220,123:120]\_[7:6][7:6,3:0][8,0]0 Phy Tx Deemphasis and Margining Control**

Table 86: Index Mapping for D0F0xE4\_x0[220,123:120]\_[7:6][7:6,3:0][8,0]0

| Pin Group | D0F0xE0[31:16] | D0F0xE0[15:0] |           |           |           |           |           |          |          |
|-----------|----------------|---------------|-----------|-----------|-----------|-----------|-----------|----------|----------|
|           |                | 6380h         | 6300h     | 6280h     | 6200h     | 6180h     | 6100h     | 6080h    | 6000h    |
| P_GFX_    | 0120h          | TX[P,N]7      | TX[P,N]6  | TX[P,N]5  | TX[P,N]4  | TX[P,N]3  | TX[P,N]2  | TX[P,N]1 | TX[P,N]0 |
| P_GFX_    | 0220h          | TX[P,N]15     | TX[P,N]14 | TX[P,N]13 | TX[P,N]12 | TX[P,N]11 | TX[P,N]10 | TX[P,N]9 | TX[P,N]8 |
| P_GPP_    | 0121h          | TX[P,N]7      | TX[P,N]6  | TX[P,N]5  | TX[P,N]4  | TX[P,N]3  | TX[P,N]2  | TX[P,N]1 | TX[P,N]0 |
| P_UMI_    | 0122h          | -             | -         | -         | -         | TX[P,N]3  | TX[P,N]2  | TX[P,N]1 | TX[P,N]0 |
| P_DP0_    | 0122h          | TX[P,N]3      | TX[P,N]2  | TX[P,N]1  | TX[P,N]0  | -         | -         | -        | -        |
| P_DP1_    | 0123h          | -             | -         | -         | -         | TX[P,N]3  | TX[P,N]2  | TX[P,N]1 | TX[P,N]0 |
| P_DP2_    | 0123h          | TX[P,N]3      | TX[P,N]2  | TX[P,N]1  | TX[P,N]0  | -         | -         | -        | -        |

**Table 87: Broadcast Mapping for D0F0xE4\_x0[220,123:120]\_[7:6][7:6,3:0][8,0]0**

| D0F0xE0[31:16] | D0F0xE0[15:0]              |                            |                            |
|----------------|----------------------------|----------------------------|----------------------------|
|                | 7700h                      | 7600h                      | 7000h                      |
| 0120h          | D0F0xE4_x0120_6[3:2][8,0]0 | D0F0xE4_x0120_6[1:0][8,0]0 | D0F0xE4_x0120_6[3:0][8,0]0 |
| 0220h          | D0F0xE4_x0220_6[3:2][8,0]0 | D0F0xE4_x0220_6[1:0][8,0]0 | D0F0xE4_x0220_6[3:0][8,0]0 |
| 0122h          | D0F0xE4_x0122_6[3:2][8,0]0 | D0F0xE4_x0122_6[1:0][8,0]0 | D0F0xE4_x0122_6[3:0][8,0]0 |
| 0122h          | D0F0xE4_x0122_6[3:2][8,0]0 | D0F0xE4_x0122_6[1:0][8,0]0 | D0F0xE4_x0122_6[3:0][8,0]0 |
| 0123h          | D0F0xE4_x0123_6[3:2][8,0]0 | D0F0xE4_x0123_6[1:0][8,0]0 | D0F0xE4_x0123_6[3:0][8,0]0 |

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                               |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:16 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                 |
| 15    | <b>DisLoImpIdle: disable low impedance idle.</b> Read-write. Reset: 0. 1= Disables the low impedance electrical idle feature that requires both the true and complement pins of the transmitter to be pulled to VDDP/2 via low impedance termination in the range of 25 to 50 ohm upon entering electrical idle state. Instead, 5k ohm termination is used. 0=Enables low impedance electrical idle mode. |
| 14:8  | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                 |
| 7     | <b>TxLs23ClkGateEn: LS2/LS3 clock gating enable.</b> Read-write. Reset: 1. 1= Internal phy clock grids are gated during LS2 or PHY OFF states to save power.                                                                                                                                                                                                                                              |
| 6:4   | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                 |

|     |                                                                                                                                         |
|-----|-----------------------------------------------------------------------------------------------------------------------------------------|
| 3   | <b>Post2Sign: Post-cursor 2 Sign.</b> Read-write. Cold-reset: 0. 1=Increases output voltage strength. 0=Lowers output voltage strength. |
| 2:0 | Reserved.                                                                                                                               |

### D0F0xE4\_x0[220,123:120]\_[7:6][7:6,3:0][8,0]6 Phy Transmit Nominal Deemphasis Control

This register specifies the deemphasis, or preemphasis settings in the case of display port mode, and voltage margining settings for the transmit drivers.

**Table 88: Recommended preemphasis settings**

| Conditions   |             |                      | D0F0xE4_x0[220,123:120]_[7:6][7:6,3:0][8,0]6 |             |
|--------------|-------------|----------------------|----------------------------------------------|-------------|
| Link Type    | Preemphasis | Peak-to-peak Voltage | DeemphGen1Nom                                | TxMarginNom |
| Display Port | 0dB         | 1.2V                 | 0                                            | 0           |
|              |             | 0.8V                 | 0                                            | 25          |
|              |             | 0.6V                 | 0                                            | 58          |
|              |             | 0.4V                 | 0                                            | 75          |
|              | 3.5dB       | 0.8V                 | 40                                           | 0           |
|              |             | 0.6V                 | 34                                           | 24          |
|              |             | 0.4V                 | 25                                           | 50          |
|              | 6dB         | 0.6V                 | 62                                           | 0           |
|              |             | 0.4V                 | 46                                           | 34          |
|              | 9.5dB       | 0.4V                 | 75                                           | 0           |
| HDMI         | -           |                      | 30                                           | 0           |
| DVI          | -           |                      | 11                                           | 0           |
| PCIe         | -           |                      | 42                                           | 0           |

Table 89: Index Mapping for D0F0xE4\_x0[220,123:120]\_[7:6][7:6,3:0][8,0]6

| Pin Group | D0F0xE0[31:16] | D0F0xE0[15:0] |           |           |           |           |           |          |          |
|-----------|----------------|---------------|-----------|-----------|-----------|-----------|-----------|----------|----------|
|           |                | 6386h         | 6306h     | 6286h     | 6206h     | 6186h     | 6106h     | 6086h    | 6006h    |
| P_GFX_    | 0120h          | TX[P,N]7      | TX[P,N]6  | TX[P,N]5  | TX[P,N]4  | TX[P,N]3  | TX[P,N]2  | TX[P,N]1 | TX[P,N]0 |
| P_GFX_    | 0220h          | TX[P,N]15     | TX[P,N]14 | TX[P,N]13 | TX[P,N]12 | TX[P,N]11 | TX[P,N]10 | TX[P,N]9 | TX[P,N]8 |
| P_GPP_    | 0121h          | TX[P,N]7      | TX[P,N]6  | TX[P,N]5  | TX[P,N]4  | TX[P,N]3  | TX[P,N]2  | TX[P,N]1 | TX[P,N]0 |
| P_UMI_    | 0122h          | -             | -         | -         | -         | TX[P,N]3  | TX[P,N]2  | TX[P,N]1 | TX[P,N]0 |
| P_DP0_    | 0122h          | TX[P,N]3      | TX[P,N]2  | TX[P,N]1  | TX[P,N]0  | -         | -         | -        | -        |
| P_DP1_    | 0123h          | -             | -         | -         | -         | TX[P,N]3  | TX[P,N]2  | TX[P,N]1 | TX[P,N]0 |
| P_DP2_    | 0123h          | TX[P,N]3      | TX[P,N]2  | TX[P,N]1  | TX[P,N]0  | -         | -         | -        | -        |

**Table 90: Broadcast Mapping for D0F0xE4\_x0[220,123:120]\_[7:6][7:6,3:0][8,0]6**

| D0F0xE0[31:16] | D0F0xE0[15:0]              |                            |                            |
|----------------|----------------------------|----------------------------|----------------------------|
|                | 7706h                      | 7606h                      | 7006h                      |
| 0120h          | D0F0xE4_x0120_6[3:2][8,0]6 | D0F0xE4_x0120_6[1:0][8,0]6 | D0F0xE4_x0120_6[3:0][8,0]6 |

**Table 90: Broadcast Mapping for D0F0xE4\_x0[220,123:120]\_[7:6][7:6,3:0][8,0]6**

|       |                            |                            |                            |
|-------|----------------------------|----------------------------|----------------------------|
| 0220h | D0F0xE4_x0220_6[3:2][8,0]6 | D0F0xE4_x0220_6[1:0][8,0]6 | D0F0xE4_x0220_6[3:0][8,0]6 |
| 0122h | D0F0xE4_x0122_6[3:2][8,0]6 | D0F0xE4_x0122_6[1:0][8,0]6 | D0F0xE4_x0122_6[3:0][8,0]6 |
| 0122h | D0F0xE4_x0122_6[3:2][8,0]6 | D0F0xE4_x0122_6[1:0][8,0]6 | D0F0xE4_x0122_6[3:0][8,0]6 |
| 0123h | D0F0xE4_x0123_6[3:2][8,0]6 | D0F0xE4_x0123_6[1:0][8,0]6 | D0F0xE4_x0123_6[3:0][8,0]6 |

| Bits  | Description                                                                                                                                                                                    |
|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:16 | Reserved.                                                                                                                                                                                      |
| 15:8  | <b>DeemphGen1Nom.</b> Read-write. Reset: 42. BIOS: <a href="#">Table 88</a> . This field specifies the post cursor deemphasis setting. Value must be less than or equal to 104. .              |
| 7:0   | <b>TxMarginNom.</b> Read-write. Reset: 0. BIOS: <a href="#">Table 88</a> . This field specifies the voltage margining setting of the transmit driver. Value must be less than or equal to 104. |

**D0F0xE4\_x0[220,123:120]\_[F:E][7:0][8,0]6 Phy Transmit Link Configuration**Table 91: [BIOS Recommendations](#) for GangedModeEn, IsOwnMstr

| Link configuration       | GangedModeEn | IsOwnMstr |
|--------------------------|--------------|-----------|
| x1 (1 lane per sublink)  | 0            | 1         |
| x2 (2 lanes per sublink) | 0            | 1         |
| x4 (4 lanes per sublink) | 0            | 0         |
| x8                       | 1            | 0         |

Table 92: [Index Mapping](#) for D0F0xE4\_x0[220,123:120]\_[F:E][7:0][8,0]6

| Pin Group | D0F0xE0[31:16] | D0F0xE0[15:0] |           |           |           |           |           |          |          |
|-----------|----------------|---------------|-----------|-----------|-----------|-----------|-----------|----------|----------|
|           |                | E386h         | E306h     | E286h     | E206h     | E186h     | E106h     | E086h    | E006h    |
| P_GFX_    | 0120h          | TX[P,N]7      | TX[P,N]6  | TX[P,N]5  | TX[P,N]4  | TX[P,N]3  | TX[P,N]2  | TX[P,N]1 | TX[P,N]0 |
| P_GFX_    | 0220h          | TX[P,N]15     | TX[P,N]14 | TX[P,N]13 | TX[P,N]12 | TX[P,N]11 | TX[P,N]10 | TX[P,N]9 | TX[P,N]8 |
| P_GPP_    | 0121h          | TX[P,N]7      | TX[P,N]6  | TX[P,N]5  | TX[P,N]4  | TX[P,N]3  | TX[P,N]2  | TX[P,N]1 | TX[P,N]0 |
| P_UMI_    | 0122h          | -             | -         | -         | -         | TX[P,N]3  | TX[P,N]2  | TX[P,N]1 | TX[P,N]0 |
| P_DP0_    | 0122h          | TX[P,N]3      | TX[P,N]2  | TX[P,N]1  | TX[P,N]0  | -         | -         | -        | -        |
| P_DP1_    | 0123h          | -             | -         | -         | -         | TX[P,N]3  | TX[P,N]2  | TX[P,N]1 | TX[P,N]0 |
| P_DP2_    | 0123h          | TX[P,N]3      | TX[P,N]2  | TX[P,N]1  | TX[P,N]0  | -         | -         | -        | -        |

**Table 93: Broadcast Mapping for D0F0xE4\_x0[220,123:120]\_[F:E][7:0][8,0]6**

| D0F0xE0[31:16] | D0F0xE0[15:0]              |                            |                            |
|----------------|----------------------------|----------------------------|----------------------------|
|                | F706h                      | F606h                      | F006h                      |
| 0120h          | D0F0xE4_x0120_E[3:2][8,0]6 | D0F0xE4_x0120_E[1:0][8,0]6 | D0F0xE4_x0120_E[3:0][8,0]6 |
| 0220h          | D0F0xE4_x0220_E[3:2][8,0]6 | D0F0xE4_x0220_E[1:0][8,0]6 | D0F0xE4_x0220_E[3:0][8,0]6 |
| 0122h          | D0F0xE4_x0122_E[3:2][8,0]6 | D0F0xE4_x0122_E[1:0][8,0]6 | D0F0xE4_x0122_E[3:0][8,0]6 |
| 0122h          | D0F0xE4_x0122_E[3:2][8,0]6 | D0F0xE4_x0122_E[1:0][8,0]6 | D0F0xE4_x0122_E[3:0][8,0]6 |
| 0123h          | D0F0xE4_x0123_E[3:2][8,0]6 | D0F0xE4_x0123_E[1:0][8,0]6 | D0F0xE4_x0123_E[3:0][8,0]6 |



| Bits      | Description                                                                                                                                                                                                                                                                                                                                                                                                                       |      |             |      |            |      |            |      |            |      |            |      |             |           |                     |
|-----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|------|------------|------|------------|------|------------|------|------------|------|-------------|-----------|---------------------|
| 31:8      | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                         |      |             |      |            |      |            |      |            |      |            |      |             |           |                     |
| 7:5       | <b>RdptInitMode.</b> Read-write. Cold-reset: 0. Sets the read-pointer init mode.<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>000b</td><td>x1 enabled</td></tr> <tr> <td>001b</td><td>x2 enabled</td></tr> <tr> <td>010b</td><td>x4 enabled</td></tr> <tr> <td>011b</td><td>x8 enabled</td></tr> <tr> <td>100b</td><td>x16 enabled</td></tr> <tr> <td>111b-101b</td><td>Disable all enables</td></tr> </table> | Bits | Description | 000b | x1 enabled | 001b | x2 enabled | 010b | x4 enabled | 011b | x8 enabled | 100b | x16 enabled | 111b-101b | Disable all enables |
| Bits      | Description                                                                                                                                                                                                                                                                                                                                                                                                                       |      |             |      |            |      |            |      |            |      |            |      |             |           |                     |
| 000b      | x1 enabled                                                                                                                                                                                                                                                                                                                                                                                                                        |      |             |      |            |      |            |      |            |      |            |      |             |           |                     |
| 001b      | x2 enabled                                                                                                                                                                                                                                                                                                                                                                                                                        |      |             |      |            |      |            |      |            |      |            |      |             |           |                     |
| 010b      | x4 enabled                                                                                                                                                                                                                                                                                                                                                                                                                        |      |             |      |            |      |            |      |            |      |            |      |             |           |                     |
| 011b      | x8 enabled                                                                                                                                                                                                                                                                                                                                                                                                                        |      |             |      |            |      |            |      |            |      |            |      |             |           |                     |
| 100b      | x16 enabled                                                                                                                                                                                                                                                                                                                                                                                                                       |      |             |      |            |      |            |      |            |      |            |      |             |           |                     |
| 111b-101b | Disable all enables                                                                                                                                                                                                                                                                                                                                                                                                               |      |             |      |            |      |            |      |            |      |            |      |             |           |                     |
| 4         | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                         |      |             |      |            |      |            |      |            |      |            |      |             |           |                     |
| 3         | <b>IncoherentCkDet.</b> Read-write. Reset: 0. 1=Indicates lane is in incoherent clock mode.                                                                                                                                                                                                                                                                                                                                       |      |             |      |            |      |            |      |            |      |            |      |             |           |                     |
| 2         | <b>IsOwnMstr.</b> Read-write. Reset: 0. BIOS: <a href="#">Table 91</a> . 1=Enables the lane to self initialize its own read pointer.                                                                                                                                                                                                                                                                                              |      |             |      |            |      |            |      |            |      |            |      |             |           |                     |
| 1         | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                          |      |             |      |            |      |            |      |            |      |            |      |             |           |                     |
| 0         | <b>GangedModeEn.</b> Read-write. Reset: 1. BIOS: <a href="#">Table 91</a> . 1=Enables link ganged mode. 0=Disables link ganged mode.                                                                                                                                                                                                                                                                                              |      |             |      |            |      |            |      |            |      |            |      |             |           |                     |

### 3.3.3 Wrapper Registers

**Table 94: Mapping for wrapper registers**

| D0F0xE0[31:16] | Wrapper | Port Description |
|----------------|---------|------------------|
| 0130h          | PGD     | Gfx+Display      |
| 0131h          | PPD     | GPP+Display      |
| 0132h          | PSD     | FCH+Display      |
| 0133h          | DDI     | Display          |

#### D0F0xE4\_x013[2:0]\_0046 Subsystem and Vendor ID

| Bits  | Description                                                                                                                                                    |
|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:16 | <b>SubsystemID: subsystem id</b> . Read-write. Reset: 1234h. Specifies the value returned by <a href="#">D[4:2]F[5:1]xB4[SubsystemID]</a> .                    |
| 15:0  | <b>SubsystemVendorID: subsystem vendor id</b> . Read-write. Reset: 1022h. Specifies the value returned by <a href="#">D[4:2]F[5:1]xB4[SubsystemVendorID]</a> . |

#### D0F0xE4\_x013[2:0]\_0080 Link Configuration

Reset: 0000\_0000h.

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |       |                             |      |            |       |                        |       |                             |       |                          |       |                          |       |                             |       |          |       |                                           |       |          |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|-----------------------------|------|------------|-------|------------------------|-------|-----------------------------|-------|--------------------------|-------|--------------------------|-------|-----------------------------|-------|----------|-------|-------------------------------------------|-------|----------|
| 31:4  | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |       |                             |      |            |       |                        |       |                             |       |                          |       |                          |       |                             |       |          |       |                                           |       |          |
| 3:0   | <b>StrapBifLinkConfig</b> . Read-write; strap. Reset: Product-specific.<br>BIOS: See <a href="#">Table 42</a> and <a href="#">Table 44</a> . <table><tr><th>Bits</th><th>Definition</th><th>Bits</th><th>Definition</th></tr><tr><td>0000b</td><td>x16 IO Link (Gfx Only)</td><td>0100b</td><td>4 x1 IO Links (GPPFCH Only)</td></tr><tr><td>0001b</td><td>x4 IO Link (GPPFCH Only)</td><td>0101b</td><td>2 x8 IO Links (Gfx Only)</td></tr><tr><td>0010b</td><td>2 x2 IO Links (GPPFCH Only)</td><td>011xb</td><td>Reserved</td></tr><tr><td>0011b</td><td>1 x2 IO Link, 2 x1 IO Links (GPPFCH Only)</td><td>1xxxb</td><td>Reserved</td></tr></table> | Bits  | Definition                  | Bits | Definition | 0000b | x16 IO Link (Gfx Only) | 0100b | 4 x1 IO Links (GPPFCH Only) | 0001b | x4 IO Link (GPPFCH Only) | 0101b | 2 x8 IO Links (Gfx Only) | 0010b | 2 x2 IO Links (GPPFCH Only) | 011xb | Reserved | 0011b | 1 x2 IO Link, 2 x1 IO Links (GPPFCH Only) | 1xxxb | Reserved |
| Bits  | Definition                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Bits  | Definition                  |      |            |       |                        |       |                             |       |                          |       |                          |       |                             |       |          |       |                                           |       |          |
| 0000b | x16 IO Link (Gfx Only)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 0100b | 4 x1 IO Links (GPPFCH Only) |      |            |       |                        |       |                             |       |                          |       |                          |       |                             |       |          |       |                                           |       |          |
| 0001b | x4 IO Link (GPPFCH Only)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 0101b | 2 x8 IO Links (Gfx Only)    |      |            |       |                        |       |                             |       |                          |       |                          |       |                             |       |          |       |                                           |       |          |
| 0010b | 2 x2 IO Links (GPPFCH Only)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 011xb | Reserved                    |      |            |       |                        |       |                             |       |                          |       |                          |       |                             |       |          |       |                                           |       |          |
| 0011b | 1 x2 IO Link, 2 x1 IO Links (GPPFCH Only)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 1xxxb | Reserved                    |      |            |       |                        |       |                             |       |                          |       |                          |       |                             |       |          |       |                                           |       |          |

#### D0F0xE4\_x013[2:0]\_0[C:8]00 Link Hold Training Control

Table 95: Index address mapping for [D0F0xE4\\_x013\[2:0\]\\_0\[C:8\]00](#)

| Index      | Function  | Index      | Function  | Index      | Function  |
|------------|-----------|------------|-----------|------------|-----------|
| 0130_0800h | PGD PortA | 0131_0800h | PPD PortA | 0132_0800h | PSD PortA |
| 0130_0900h | PGD PortB | 0131_0900h | PPD PortB | 0132_0900h | PSD PortB |
| -          | -         | 0131_0A00h | PPD PortC | 0132_0A00h | PSD PortC |
| -          | -         | 0131_0B00h | PPD PortD | 0132_0B00h | PSD PortD |
| -          | -         | 0131_0C00h | PPD PortE | 0132_0C00h | PSD PortE |

| Bits | Description                                                                             |
|------|-----------------------------------------------------------------------------------------|
| 31:1 | Reserved.                                                                               |
| 0    | <b>HoldTraining: hold link training.</b> Read-write. Reset: 1. 1=Hold training on link. |

### **D0F0xE4\_x013[2:0]\_0[C:8]03 Link Deemphasis Control**

Table 96: Index address mapping for [D0F0xE4\\_x013\[2:0\]\\_0\[C:8\]03](#)

| Index      | Function  | Index      | Function  | Index      | Function  |
|------------|-----------|------------|-----------|------------|-----------|
| 0130_0803h | PGD PortA | 0131_0803h | PPD PortA | 0132_0803h | PSD PortA |
| 0130_0903h | PGD PortB | 0131_0903h | PPD PortB | 0132_0903h | PSD PortB |
| -          | -         | 0131_0A03h | PPD PortC | 0132_0A03h | PSD PortC |
| -          | -         | 0131_0B03h | PPD PortD | 0132_0B03h | PSD PortD |
| -          | -         | 0131_0C03h | PPD PortE | 0132_0C03h | PSD PortE |

| Bits | Description                                                                                                                                                                                    |
|------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:6 | Reserved.                                                                                                                                                                                      |
| 5    | <b>StrapBifDeemphasisSel.</b> Read-write; strap. Reset: 1. Controls the default value of <a href="#">D[4:2]F[5:1]x88[SelectableDeemphasis]</a> . 1=RC advertises -3.5dB. 0=RC advertises -6dB. |
| 4:0  | Reserved.                                                                                                                                                                                      |

### **D0F0xE4\_x013[3:0]\_8002 IO Link Wrapper Scratch**

Cold reset: 0000\_0000h.

| Bits | Description                                  |
|------|----------------------------------------------|
| 31:0 | <b>PcieWrapScratch: Scratch.</b> Read-write. |

### **D0F0xE4\_x013[3:0]\_8011 Link Transmit Clock Gating Control**

| Bits  | Description                                                                                                                                                                  |
|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:26 | Reserved.                                                                                                                                                                    |
| 25    | Reserved.                                                                                                                                                                    |
| 24    | <b>TxclkLcntGateEnable.</b> Read-write. Reset: 0. BIOS: 1. 1=Enable clock gating the lane counter.                                                                           |
| 23    | <b>DebugBusClkEnable.</b> Read-write. Reset: 1. BIOS: 0. 1=Enable the debug bus clock.                                                                                       |
| 22:17 | <b>TxclkPermGateLatency.</b> Read-write. Reset: 3Fh. Specifies the number of clocks to wait after detecting an entry into L1 before gating off the permanent clock branches. |
| 16    | <b>RcvrDetClkEnable.</b> Read-write. Reset: 0. 1=Enable the receiver detect clock.                                                                                           |
| 15:10 | <b>TxclkRegsGateLatency.</b> Read-write. Reset: 3Fh. Specifies the number of clocks to wait after idle is signalled before gating off the register clock branch.             |
| 9     | <b>TxclkRegsGateEnable.</b> Read-write. Reset: 0. BIOS: 1. 1=Enable clock gating the register clock.                                                                         |
| 8     | <b>TxclkPermStop.</b> Read-write. Reset: 0. 1=All transmitter clocks disabled. This bit should only be set if all links associated with the PCIe core are unconnected.       |

|     |                                                                                                                                                                |
|-----|----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 7   | <b>TxclkDynGateEnable.</b> Read-write. Reset: 0. BIOS: 1. 1=Dynamic clock gating enabled. 0=Dynamic clock gating disabled.                                     |
| 6   | <b>TxclkPermGateEven.</b> Read-write. Reset: 1. 1=Gate the permanent clock branches for an even number of clocks.                                              |
| 5:0 | <b>TxclkDynGateLatency.</b> Read-write. Reset: 3Fh. Specifies the number of clocks to wait after idle is signalled before gating off the dynamic clock branch. |

#### **D0F0xE4\_x013[3:0]\_8012 Link Idle-Resume Clock Gating Control**

| Bits  | Description                                                                                                                                                   |
|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:14 | Reserved.                                                                                                                                                     |
| 13:8  | <b>Pif1xIdleResumeLatency.</b> Read-write. Reset: 00_0111b. Specifies the number of clocks to wait after enabling TXCLK1X_PIF before sending the acknowledge. |
| 7     | <b>Pif1xIdleGateEnable.</b> Read-write. Reset: 0. BIOS: 1. 1=Enable idle resume gating of TXCLK1X_PIF.                                                        |
| 6     | Reserved.                                                                                                                                                     |
| 5:0   | <b>Pif1xIdleGateLatency.</b> Read-write. Reset: 0_0001b. Specifies the number of clocks to wait before turning off TXCLK1X_PIF.                               |

#### **D0F0xE4\_x013[3:0]\_8013 Transmit Clock Pll Control**

Reset: 0000\_0001h.

Table 97: Reserved field mappings for [D0F0xE4\\_x013\[3:0\]\\_8013](#)

| Register           | Bits     |          |          |          |
|--------------------|----------|----------|----------|----------|
|                    | 31:24    | 12:11    | 7:6      | 3:2      |
| D0F0xE4_x0130_8013 | -        | -        | -        | -        |
| D0F0xE4_x0131_8013 | Reserved | Reserved | Reserved | Reserved |
| D0F0xE4_x0132_8013 | Reserved | Reserved | Reserved | Reserved |
| D0F0xE4_x0133_8013 | Reserved | Reserved | Reserved | Reserved |

| Bits  | Description                                                               |
|-------|---------------------------------------------------------------------------|
| 31    | <b>TxclkSelDigDOverride.</b> Read-write. 1=Override TXCLK_DIGD selection. |
| 30:28 | <b>TxclkSelDigD.</b> Read-write. Select clock from PLL A, B, C, D.        |
| 27    | <b>TxclkSelDigCOverride.</b> Read-write. 1=Override TXCLK_DIGC selection. |
| 26:24 | <b>TxclkSelDigC.</b> Read-write. Select clock from PLL A, B, C, D.        |
| 23    | <b>TxclkSelDigBOverride.</b> Read-write. 1=Override TXCLK_DIGB selection. |
| 22:20 | <b>TxclkSelDigB.</b> Read-write. Select clock from PLL A, B, C, D.        |
| 19    | <b>TxclkSelDigAOverride.</b> Read-write. 1=Override TXCLK_DIGA selection. |
| 18:16 | <b>TxclkSelDigA.</b> Read-write. Select clock from PLL A, B, C, D.        |
| 15:13 | Reserved.                                                                 |
| 12    | <b>TxclkSelPifDOverride.</b> Read-write. 1=Override TxclkPifD selection.  |

|    |                                                                                                           |
|----|-----------------------------------------------------------------------------------------------------------|
| 11 | <b>TxclkSelPifCOverride</b> . Read-write. 1=Override TxclkPifC selection.                                 |
| 10 | <b>TxclkSelPifBOverride</b> . Read-write. 1=Override TxclkPifB selection.                                 |
| 9  | <b>TxclkSelPifAOverride</b> . Read-write. 1=Override TxclkPifA selection.                                 |
| 8  | <b>TxclkSelCoreOverride</b> . Read-write. 1=Override TxclkCore selection.                                 |
| 7  | <b>ClkDividerResetOverrideD</b> . Read-write. 1=Force clock divider D enabled.                            |
| 6  | <b>ClkDividerResetOverrideC</b> . Read-write. 1=Force clock divider C enabled.                            |
| 5  | <b>ClkDividerResetOverrideB</b> . Read-write. 1=Force clock divider B enabled.                            |
| 4  | <b>ClkDividerResetOverrideA</b> . Read-write. 1=Force clock divider A enabled.                            |
| 3  | <b>MasterPciePllD</b> . Read-write. 1=Pll D is the master source for all PCIe transmitter clock branches. |
| 2  | <b>MasterPciePllC</b> . Read-write. 1=Pll C is the master source for all PCIe transmitter clock branches. |
| 1  | <b>MasterPciePllB</b> . Read-write. 1=Pll B is the master source for all PCIe transmitter clock branches. |
| 0  | <b>MasterPciePllA</b> . Read-write. 1=Pll A is the master source for all PCIe transmitter clock branches. |

### **D0F0xE4\_x013[3:0]\_8014 Link Transmit Clock Gating Control 2**

Reset: 0000\_0000h.

**Table 98: Reserved field mappings for D0F0xE4\_x013[3:0]\_8014**

| Register           | Bits     |          |          |          |          |          |
|--------------------|----------|----------|----------|----------|----------|----------|
|                    | 27       | 26       | 15       | 14       | 5        | 4        |
| D0F0xE4_x0130_8014 | -        | -        | -        | -        | -        | -        |
| D0F0xE4_x0131_8014 | Reserved | Reserved | Reserved | Reserved | Reserved | Reserved |
| D0F0xE4_x0132_8014 | Reserved | Reserved | Reserved | Reserved | Reserved | Reserved |
| D0F0xE4_x0133_8014 | Reserved | Reserved | Reserved | Reserved | Reserved | Reserved |

| Bits  | Description                                                                                                                                  |
|-------|----------------------------------------------------------------------------------------------------------------------------------------------|
| 31:28 | <b>SpareRegRw</b> . Read-write. Spare register.                                                                                              |
| 27    | <b>DdiDigdGateEnable</b> . Read-write. 1=Enable gating of the DIG D clock branch in DDI mode.                                                |
| 26    | <b>DdiDigcGateEnable</b> . Read-write. 1=Enable gating of the DIG C clock branch in DDI mode.                                                |
| 25    | <b>DdiDigbGateEnable</b> . Read-write. 1=Enable gating of the DIG B clock branch in DDI mode.                                                |
| 24    | <b>DdiDigaGateEnable</b> . Read-write. 1=Enable gating of the DIG A clock branch in DDI mode.                                                |
| 23:21 | Reserved.                                                                                                                                    |
| 20    | <b>TxclkPermGateOnlyWhenPllPwrDn</b> . Read-write. BIOS: 1. 1=Gating of the permanent clock branch only occurs when the PLL is powered down. |
| 19:16 | Reserved.                                                                                                                                    |
| 15    | <b>PcieGatePifD1xEnable</b> . Read-write. BIOS: 1. 1=Enable gating of the PIF D 1x clock branches in PCIe mode.                              |

|      |                                                                                                                |
|------|----------------------------------------------------------------------------------------------------------------|
| 14   | <b>PcieGatePifC1xEnable.</b> Read-write. BIOS: 1. 1=Enable gating of the PIF C 1x clock branches in PCIe mode. |
| 13   | <b>PcieGatePifB1xEnable.</b> Read-write. BIOS: 1. 1=Enable gating of the PIF B 1x clock branches in PCIe mode. |
| 12   | <b>PcieGatePifA1xEnable.</b> Read-write. BIOS: 1. 1=Enable gating of the PIF A 1x clock branches in PCIe mode. |
| 11:6 | Reserved.                                                                                                      |
| 5    | <b>DdiPifd1xGateEnable.</b> Read-write. 1=Enable gating of the PIF D 1x clock branch in DDI mode.              |
| 4    | <b>DdiPifc1xGateEnable.</b> Read-write. 1=Enable gating of the PIF C 1x clock branch in DDI mode.              |
| 3    | <b>DdiPifb1xGateEnable.</b> Read-write. 1=Enable gating of the PIF B 1x clock branch in DDI mode.              |
| 2    | <b>DdiPifa1xGateEnable.</b> Read-write. 1=Enable gating of the PIF A 1x clock branches in DDI mode.            |
| 1    | <b>TxclkPrbsGateEnable.</b> Read-write. BIOS: 1. 1=Enable gating of the PRBS clock branch.                     |
| 0    | <b>TxclkPermGateEnable.</b> Read-write. BIOS: 1. 1=Enable gating of the permanent clock branch.                |

#### D0F0xE4\_x013[3:0]\_8015 IO Link IOC Control

| Bits  | Description                                                                                                                 |
|-------|-----------------------------------------------------------------------------------------------------------------------------|
| 31:24 | Reserved.                                                                                                                   |
| 23    | <b>RefclkRegsGateEnable.</b> Read-write. Reset:0. BIOS: 1. 1=Enable gating of REFCLK_REGS.                                  |
| 22    | Reserved.                                                                                                                   |
| 21:16 | <b>RefclkRegsGateLatency.</b> Read-write. Reset:3Fh. Specifies the number of clocks to wait before turning off REFCLK_REGS. |
| 15:0  | Reserved.                                                                                                                   |

#### D0F0xE4\_x013[3:0]\_8016 Link Clock Switching Control

Reset: 003F\_001Fh.

| Bits  | Description                                                                                                                                      |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:24 | Reserved.                                                                                                                                        |
| 23    | <b>LclkDynGateEnable.</b> Read-write. 1=Enable LCLK_DYN clock gating.                                                                            |
| 22    | <b>LclkGateFree.</b> Read-write. IF (REG== D0F0xE4_x013[1:0]_8016) THEN BIOS: 1. ENDIF. 1=LCLK gating is controlled independent of TXCLK gating. |
| 21:16 | <b>LclkDynGateLatency.</b> Read-write. Specifies the number of clocks to wait before turning off LCLK_DYN.                                       |

|      |                                                                                                                                                                                                               |
|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 15:6 | Reserved.                                                                                                                                                                                                     |
| 5:0  | <b>CalibAckLatency</b> . Read-write.<br>BIOS: IF (REG==D0F0xE4_x0132_8016) THEN 0 ELSE 1Fh. ENDIF.<br>Specifies the number of clocks after calibration is complete before the acknowledge signal is asserted. |

### D0F0xE4\_x013[3:0]\_802[4:1] Transmitter Lane Mux

Table 99: Lane index addresses for [D0F0xE4\\_x013\[3:0\]\\_802\[4:1\]](#)

| D0F0xE0[31:4]             | D0F0xE0[3:0] |             |            |            |
|---------------------------|--------------|-------------|------------|------------|
|                           | 4h           | 3h          | 2h         | 1h         |
| <a href="#">0130_802h</a> | Lanes[15:12] | Lanes[11:8] | Lanes[7:4] | Lanes[3:0] |
| <a href="#">0131_802h</a> | Lanes[15:12] | Lanes[11:8] | Lanes[7:4] | Lanes[3:0] |
| <a href="#">0132_802h</a> | Lanes[15:12] | Lanes[11:8] | Lanes[7:4] | Lanes[3:0] |
| <a href="#">0133_802h</a> | Lanes[15:12] | Lanes[11:8] | Lanes[7:4] | Lanes[3:0] |

Table 100: Reset Mapping for [D0F0xE4\\_x013\[3:0\]\\_802\[4:1\]](#)

| Register               | Reset      |
|------------------------|------------|
| D0F0xE4_x013[3:0]_8024 | 0F0E_0D0Ch |
| D0F0xE4_x013[3:0]_8023 | 0B0A_0908h |
| D0F0xE4_x013[3:0]_8022 | 0706_0504h |
| D0F0xE4_x013[3:0]_8021 | 0302_0100h |

Table 101: Field mapping for [D0F0xE4\\_x013\[3:0\]\\_802\[4:1\]](#)

| Register               | Bits     |          |          |          |
|------------------------|----------|----------|----------|----------|
|                        | 31:24    | 23:16    | 15:8     | 7:0      |
| D0F0xE4_x013[3:0]_8024 | TXLane15 | TXLane14 | TXLane13 | TXLane12 |
| D0F0xE4_x013[3:0]_8023 | TXLane11 | TXLane10 | TXLane9  | TXLane8  |
| D0F0xE4_x013[3:0]_8022 | TXLane7  | TXLane6  | TXLane5  | TXLane4  |
| D0F0xE4_x013[3:0]_8021 | TXLane3  | TXLane2  | TXLane1  | TXLane0  |

| Bits  | Description                                                                                                                                                |
|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:24 | <b>TXLane</b> . Read-write. Specifies the controller lanes that are mapped to TX lane n of the PIF. See: <a href="#">D0F0xE4_x013[3:0]_802[4:1][7:0]</a> . |
| 23:16 | <b>TXLane</b> . Read-write. Specifies the controller lanes that are mapped to TX lane n of the PIF. See: <a href="#">D0F0xE4_x013[3:0]_802[4:1][7:0]</a> . |

| 15:8 | <b>TXLane.</b> Read-write. Specifies the controller lanes that are mapped to TX lane n of the PIF. See: <a href="#">D0F0xE4_x013[3:0]_802[4:1][7:0]</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |      |                     |      |            |      |            |    |                    |    |                    |    |                    |    |                    |    |                    |     |                     |    |                    |     |                     |    |                    |     |                     |    |                    |     |                     |    |                    |     |                     |    |                    |     |                     |
|------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|---------------------|------|------------|------|------------|----|--------------------|----|--------------------|----|--------------------|----|--------------------|----|--------------------|-----|---------------------|----|--------------------|-----|---------------------|----|--------------------|-----|---------------------|----|--------------------|-----|---------------------|----|--------------------|-----|---------------------|----|--------------------|-----|---------------------|
| 7:0  | <b>TXLane.</b> Read-write. Specifies the controller lanes that are mapped to TX lane n of the PIF. <table> <tr> <th>Bits</th><th>Definition</th><th>Bits</th><th>Definition</th></tr> <tr> <td>0h</td><td>Controller lane 0.</td><td>8h</td><td>Controller lane 8.</td></tr> <tr> <td>1h</td><td>Controller lane 1.</td><td>9h</td><td>Controller lane 9.</td></tr> <tr> <td>2h</td><td>Controller lane 2.</td><td>10h</td><td>Controller lane 10.</td></tr> <tr> <td>3h</td><td>Controller lane 3.</td><td>11h</td><td>Controller lane 11.</td></tr> <tr> <td>4h</td><td>Controller lane 4.</td><td>12h</td><td>Controller lane 12.</td></tr> <tr> <td>5h</td><td>Controller lane 5.</td><td>13h</td><td>Controller lane 13.</td></tr> <tr> <td>6h</td><td>Controller lane 6.</td><td>14h</td><td>Controller lane 14.</td></tr> <tr> <td>7h</td><td>Controller lane 7.</td><td>15h</td><td>Controller lane 15.</td></tr> </table> |      |                     | Bits | Definition | Bits | Definition | 0h | Controller lane 0. | 8h | Controller lane 8. | 1h | Controller lane 1. | 9h | Controller lane 9. | 2h | Controller lane 2. | 10h | Controller lane 10. | 3h | Controller lane 3. | 11h | Controller lane 11. | 4h | Controller lane 4. | 12h | Controller lane 12. | 5h | Controller lane 5. | 13h | Controller lane 13. | 6h | Controller lane 6. | 14h | Controller lane 14. | 7h | Controller lane 7. | 15h | Controller lane 15. |
| Bits | Definition                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Bits | Definition          |      |            |      |            |    |                    |    |                    |    |                    |    |                    |    |                    |     |                     |    |                    |     |                     |    |                    |     |                     |    |                    |     |                     |    |                    |     |                     |    |                    |     |                     |
| 0h   | Controller lane 0.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 8h   | Controller lane 8.  |      |            |      |            |    |                    |    |                    |    |                    |    |                    |    |                    |     |                     |    |                    |     |                     |    |                    |     |                     |    |                    |     |                     |    |                    |     |                     |    |                    |     |                     |
| 1h   | Controller lane 1.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 9h   | Controller lane 9.  |      |            |      |            |    |                    |    |                    |    |                    |    |                    |    |                    |     |                     |    |                    |     |                     |    |                    |     |                     |    |                    |     |                     |    |                    |     |                     |    |                    |     |                     |
| 2h   | Controller lane 2.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 10h  | Controller lane 10. |      |            |      |            |    |                    |    |                    |    |                    |    |                    |    |                    |     |                     |    |                    |     |                     |    |                    |     |                     |    |                    |     |                     |    |                    |     |                     |    |                    |     |                     |
| 3h   | Controller lane 3.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 11h  | Controller lane 11. |      |            |      |            |    |                    |    |                    |    |                    |    |                    |    |                    |     |                     |    |                    |     |                     |    |                    |     |                     |    |                    |     |                     |    |                    |     |                     |    |                    |     |                     |
| 4h   | Controller lane 4.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 12h  | Controller lane 12. |      |            |      |            |    |                    |    |                    |    |                    |    |                    |    |                    |     |                     |    |                    |     |                     |    |                    |     |                     |    |                    |     |                     |    |                    |     |                     |    |                    |     |                     |
| 5h   | Controller lane 5.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 13h  | Controller lane 13. |      |            |      |            |    |                    |    |                    |    |                    |    |                    |    |                    |     |                     |    |                    |     |                     |    |                    |     |                     |    |                    |     |                     |    |                    |     |                     |    |                    |     |                     |
| 6h   | Controller lane 6.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 14h  | Controller lane 14. |      |            |      |            |    |                    |    |                    |    |                    |    |                    |    |                    |     |                     |    |                    |     |                     |    |                    |     |                     |    |                    |     |                     |    |                    |     |                     |    |                    |     |                     |
| 7h   | Controller lane 7.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 15h  | Controller lane 15. |      |            |      |            |    |                    |    |                    |    |                    |    |                    |    |                    |     |                     |    |                    |     |                     |    |                    |     |                     |    |                    |     |                     |    |                    |     |                     |    |                    |     |                     |

### **D0F0xE4\_x013[3:0]\_802[8:5] Receiver Lane Mux**

Reset: 0302\_0100h.

Table 102: Lane index addresses for [D0F0xE4\\_x013\[3:0\]\\_802\[8:5\]](#)

| D0F0xE0[31:4]             | D0F0xE0[3:0] |             |            |            |
|---------------------------|--------------|-------------|------------|------------|
|                           | 8h           | 7h          | 6h         | 5h         |
| <a href="#">0130_802h</a> | Lanes[15:12] | Lanes[11:8] | Lanes[7:4] | Lanes[3:0] |
| <a href="#">0131_802h</a> | Lanes[15:12] | Lanes[11:8] | Lanes[7:4] | Lanes[3:0] |
| <a href="#">0132_802h</a> | Lanes[15:12] | Lanes[11:8] | Lanes[7:4] | Lanes[3:0] |
| <a href="#">0133_802h</a> | Lanes[15:12] | Lanes[11:8] | Lanes[7:4] | Lanes[3:0] |

Table 103: [Reset Mapping](#) for [D0F0xE4\\_x013\[3:0\]\\_802\[8:5\]](#)

| Register                               | Reset      |
|----------------------------------------|------------|
| D0F0xE4_x013[3:0]_8028                 | 0F0E_0D0Ch |
| D0F0xE4_x013[3:0]_8027                 | 0B0A_0908h |
| <a href="#">D0F0xE4_x013[3:0]_8026</a> | 0706_0504h |
| D0F0xE4_x013[3:0]_8025                 | 0302_0100h |

Table 104: Field mapping for [D0F0xE4\\_x013\[3:0\]\\_802\[8:5\]](#)

| Register               | Bits     |          |          |          |
|------------------------|----------|----------|----------|----------|
|                        | 31:24    | 23:16    | 15:8     | 7:0      |
| D0F0xE4_x013[3:0]_8028 | RXLane15 | RXLane14 | RXLane13 | RXLane12 |
| D0F0xE4_x013[3:0]_8027 | RXLane11 | RXLane10 | RXLane9  | RXLane8  |
| D0F0xE4_x013[3:0]_8026 | RXLane7  | RXLane6  | RXLane5  | RXLane4  |
| D0F0xE4_x013[3:0]_8025 | RXLane3  | RXLane2  | RXLane1  | RXLane0  |

| Bits  | Description                                                                                                                                        |
|-------|----------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:24 | <b>RXLane.</b> Read-write. Specifies the PIF RX lanes that are mapped to controller lane n. See: <a href="#">D0F0xE4_x013[3:0]_802[8:5][7:0]</a> . |



|       |                                                                                                                                                    |                   |             |                   |
|-------|----------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|-------------|-------------------|
| 23:16 | <b>RXLane.</b> Read-write. Specifies the PIF RX lanes that are mapped to controller lane n. See: <a href="#">D0F0xE4_x013[3:0]_802[8:5][7:0]</a> . |                   |             |                   |
| 15:8  | <b>RXLane.</b> Read-write. Specifies the PIF RX lanes that are mapped to controller lane n. See: <a href="#">D0F0xE4_x013[3:0]_802[8:5][7:0]</a> . |                   |             |                   |
| 7:0   | <b>RXLane.</b> Read-write. Specifies the PIF RX lanes that are mapped to controller lane n.                                                        |                   |             |                   |
|       | <u>Bits</u>                                                                                                                                        | <u>Definition</u> | <u>Bits</u> | <u>Definition</u> |
|       | 0h                                                                                                                                                 | PIF RX lane 0.    | 8h          | PIF RX lane 8.    |
|       | 1h                                                                                                                                                 | PIF RX lane 1.    | 9h          | PIF RX lane 9.    |
|       | 2h                                                                                                                                                 | PIF RX lane 2.    | 10h         | PIF RX lane 10.   |
|       | 3h                                                                                                                                                 | PIF RX lane 3.    | 11h         | PIF RX lane 11.   |
|       | 4h                                                                                                                                                 | PIF RX lane 4.    | 12h         | PIF RX lane 12.   |
|       | 5h                                                                                                                                                 | PIF RX lane 5.    | 13h         | PIF RX lane 13.   |
|       | 6h                                                                                                                                                 | PIF RX lane 6.    | 14h         | PIF RX lane 14.   |
|       | 7h                                                                                                                                                 | PIF RX lane 7.    | 15h         | PIF RX lane 15.   |

### **D0F0xE4\_x013[3:0]\_8029 Lane Enable**

Reset: 0000\_FFFFh.

| Bits   | Description                                                                                                                                                                          |     |            |        |                   |
|--------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|------------|--------|-------------------|
| 31:16  | Reserved.                                                                                                                                                                            |     |            |        |                   |
| 15:0   | <b>LaneEnable</b> . Read-write. 1=Lane enabled for transmit.<br><table> <tr> <th>Bit</th><th>Definition</th></tr> <tr> <td>[15:0]</td><td>Lane &lt;BIT&gt; enable</td></tr> </table> | Bit | Definition | [15:0] | Lane <BIT> enable |
| Bit    | Definition                                                                                                                                                                           |     |            |        |                   |
| [15:0] | Lane <BIT> enable                                                                                                                                                                    |     |            |        |                   |

### **D0F0xE4\_x013[3:0]\_804[3:0] DDI Slice**

Reset: 0000\_0000h.

Table 105: Index address mapping for [D0F0xE4\\_x013\[3:0\]\\_804\[3:0\]](#)

| <a href="#">D0F0xE0[31:16]</a> | <a href="#">D0F0xE0[15:0]</a> |               |                |                 |
|--------------------------------|-------------------------------|---------------|----------------|-----------------|
|                                | 8040h                         | 8041h         | 8042h          | 8043h           |
| 0130h                          | PGD Lanes 0-3                 | PGD Lanes 4-7 | PGD Lanes 8-11 | PGD Lanes 12-15 |
| 0131h                          | PPD Lanes 0-3                 | PPD Lanes 4-7 | PPD Lanes 8-11 | PPD Lanes 12-15 |
| 0132h                          | PSD Lanes 0-3                 | PSD Lanes 4-7 | PSD Lanes 8-11 | PSD Lanes 12-15 |
| 0133h                          | DDI Lanes 0-3                 | DDI Lanes 4-7 | DDI Lanes 8-11 | DDI Lanes 12-15 |

| Bits | Description                                                                                                      |
|------|------------------------------------------------------------------------------------------------------------------|
| 31:1 | Reserved.                                                                                                        |
| 0    | <b>OwnSlice</b> . Read-write. 1=DDI asserts control over the PCIe lanes specified in <a href="#">Table 105</a> . |

**D0F0xE4\_x013[3:0]\_804[E:8] DDI Dig**

Reset: 0000\_0701h.

Table 106: Register mappings for [D0F0xE4\\_x013\[3:0\]\\_804\[E:8\]](#)

| <a href="#">D0F0xE4_x013[3:0]_804[E:8]</a> | Function |
|--------------------------------------------|----------|
| D0F0xE4_x013[3:0]_8048                     | Stream A |
| D0F0xE4_x013[3:0]_8049                     | Stream B |
| D0F0xE4_x013[3:0]_804A                     | Stream C |
| D0F0xE4_x013[3:0]_804B                     | Stream D |
| D0F0xE4_x013[3:0]_804C                     | Stream E |
| D0F0xE4_x013[3:0]_804D                     | Stream F |
| D0F0xE4_x013[3:0]_804E                     | Stream G |

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |      |                  |      |            |      |     |      |                  |      |                  |      |           |      |                 |      |           |      |           |      |      |
|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------------------|------|------------|------|-----|------|------------------|------|------------------|------|-----------|------|-----------------|------|-----------|------|-----------|------|------|
| 31:26 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |      |                  |      |            |      |     |      |                  |      |                  |      |           |      |                 |      |           |      |           |      |      |
| 25    | <b>CntDig</b> . Read-write. 1=Software asserts control over Dig TxPhyCmd and LinkSpeed.                                                                                                                                                                                                                                                                                                                                                                                                                                       |      |                  |      |            |      |     |      |                  |      |                  |      |           |      |                 |      |           |      |           |      |      |
| 24    | <b>CntPhy</b> . Read-write. 1=Software asserts control over the phy state machine.                                                                                                                                                                                                                                                                                                                                                                                                                                            |      |                  |      |            |      |     |      |                  |      |                  |      |           |      |                 |      |           |      |           |      |      |
| 23    | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |      |                  |      |            |      |     |      |                  |      |                  |      |           |      |                 |      |           |      |           |      |      |
| 22    | <b>Nxt_Lnspsd</b> . Read-write. 1=Set the value for the dig link speed in case of an override.                                                                                                                                                                                                                                                                                                                                                                                                                                |      |                  |      |            |      |     |      |                  |      |                  |      |           |      |                 |      |           |      |           |      |      |
| 21:19 | <b>Nxt_phycmd</b> . Read-write. 1=Set the value for the dig Tx phy command in case of an override.                                                                                                                                                                                                                                                                                                                                                                                                                            |      |                  |      |            |      |     |      |                  |      |                  |      |           |      |                 |      |           |      |           |      |      |
| 18:16 | <b>Nxt_State</b> . Read-write. This specifies the next state for the DDI FSM.                                                                                                                                                                                                                                                                                                                                                                                                                                                 |      |                  |      |            |      |     |      |                  |      |                  |      |           |      |                 |      |           |      |           |      |      |
| 15:11 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |      |                  |      |            |      |     |      |                  |      |                  |      |           |      |                 |      |           |      |           |      |      |
| 10:8  | <b>Dig_pwrdsn_value</b> . Read-write. Specifies the phy power state for links associated with dig streams that are not enabled. <table><tr><th>Bits</th><th>Definition</th><th>Bits</th><th>Definition</th></tr><tr><td>000b</td><td>On.</td><td>100b</td><td>Receiver detect.</td></tr><tr><td>001b</td><td>Standby 1 (L0s).</td><td>101b</td><td>Reserved.</td></tr><tr><td>010b</td><td>Standby 2 (L1).</td><td>110b</td><td>Reserved.</td></tr><tr><td>011b</td><td>Reserved.</td><td>111b</td><td>Off.</td></tr></table> | Bits | Definition       | Bits | Definition | 000b | On. | 100b | Receiver detect. | 001b | Standby 1 (L0s). | 101b | Reserved. | 010b | Standby 2 (L1). | 110b | Reserved. | 011b | Reserved. | 111b | Off. |
| Bits  | Definition                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Bits | Definition       |      |            |      |     |      |                  |      |                  |      |           |      |                 |      |           |      |           |      |      |
| 000b  | On.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 100b | Receiver detect. |      |            |      |     |      |                  |      |                  |      |           |      |                 |      |           |      |           |      |      |
| 001b  | Standby 1 (L0s).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 101b | Reserved.        |      |            |      |     |      |                  |      |                  |      |           |      |                 |      |           |      |           |      |      |
| 010b  | Standby 2 (L1).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 110b | Reserved.        |      |            |      |     |      |                  |      |                  |      |           |      |                 |      |           |      |           |      |      |
| 011b  | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 111b | Off.             |      |            |      |     |      |                  |      |                  |      |           |      |                 |      |           |      |           |      |      |
| 7     | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |      |                  |      |            |      |     |      |                  |      |                  |      |           |      |                 |      |           |      |           |      |      |
| 6     | <b>Hbr2Support</b> . Read-write. 1=HBR is supported.                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |      |                  |      |            |      |     |      |                  |      |                  |      |           |      |                 |      |           |      |           |      |      |
| 5     | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |      |                  |      |            |      |     |      |                  |      |                  |      |           |      |                 |      |           |      |           |      |      |
| 4     | <b>Hbr2Active</b> . Read-write. 1=If (Hbr2Support==1) THEN HBR2 will be enabled.                                                                                                                                                                                                                                                                                                                                                                                                                                              |      |                  |      |            |      |     |      |                  |      |                  |      |           |      |                 |      |           |      |           |      |      |
| 3     | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |      |                  |      |            |      |     |      |                  |      |                  |      |           |      |                 |      |           |      |           |      |      |
| 2     | <b>PwrDnCpl</b> . Read-only. 1=PHY state machine is in the powered up state.                                                                                                                                                                                                                                                                                                                                                                                                                                                  |      |                  |      |            |      |     |      |                  |      |                  |      |           |      |                 |      |           |      |           |      |      |
| 1     | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |      |                  |      |            |      |     |      |                  |      |                  |      |           |      |                 |      |           |      |           |      |      |
| 0     | <b>PwrDnCpl</b> . Read-only. 1=PHY state machine is in the power off state.                                                                                                                                                                                                                                                                                                                                                                                                                                                   |      |                  |      |            |      |     |      |                  |      |                  |      |           |      |                 |      |           |      |           |      |      |

**D0F0xE4\_x013[3:0]\_8060 Soft Reset Command 0**

Cold reset: 0000\_0000h.

Table 107: Reserved field mappings for D0F0xE4\_x013[3:0]\_8060

| Register           | Bits     |
|--------------------|----------|
|                    | 31:16    |
| D0F0xE4_x0130_8060 | -        |
| D0F0xE4_x0131_8060 | -        |
| D0F0xE4_x0132_8060 | -        |
| D0F0xE4_x0133_8060 | Reserved |

| Bits  | Description                                                                                                                      |
|-------|----------------------------------------------------------------------------------------------------------------------------------|
| 31:18 | Reserved.                                                                                                                        |
| 17    | <b>Bif0CalibrationReset</b> . Read-write. 1=The BIF 0 calibration block reset is asserted.                                       |
| 16    | <b>Bif0GlobalReset</b> . Read-write. 1=The BIF 0 global reset is asserted.                                                       |
| 15:4  | Reserved.                                                                                                                        |
| 3     | <b>WaitState</b> . Read-only. 1=Reset cycle is in the wait state.                                                                |
| 2     | <b>ResetComplete</b> . Read-only. 1=Reset cycle is complete.                                                                     |
| 1     | Reserved.                                                                                                                        |
| 0     | <b>Reconfigure</b> . Read-write; Cleared-when-done. 1=Trigger atomic reconfiguration if D0F0xE4_x013[3:0]_8062[ReconfigureEn]=1. |

**D0F0xE4\_x013[3:0]\_8062 Soft Reset Control 0**

Cold reset: 0001\_0880h.

| Bits  | Description                                                                                                                                                                                      |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:12 | Reserved.                                                                                                                                                                                        |
| 11    | <b>ConfigXferMode</b> . Read-write. 1=PCIe core strap settings take effect immediately. 0=PCIe core strap settings take effect when the PCIe core is reset.                                      |
| 10    | <b>BlockOnIdle</b> . Read-write. 1=The PCIe core must be idle before hardware initiates a reconfiguration. 0=The PCIe core does not have to be idle before hardware initiates a reconfiguration. |
| 9:5   | Reserved.                                                                                                                                                                                        |
| 4:2   | <b>ResetPeriod</b> . Read-write. BIOS:0. Specifies the amount of time that resets are asserted during a reconfiguration. 5h-7h: Reserved.                                                        |
| 1     | Reserved.                                                                                                                                                                                        |
| 0     | <b>ReconfigureEn</b> . Read-write. 1=Atomic reconfiguration enabled.                                                                                                                             |

**D0F0xE4\_x0132\_80F0 BIOS Timer**

Reset: 0000\_0000h.

| Bits | Description                                                                                                                                                                                                                                                                                                 |
|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:0 | <b>MicroSeconds.</b> Read-write; Updated-by-hardware. This field increments once every microsecond when the timer is enabled. The counter rolls over and continues counting when it reaches its FFFF_FFFFh. A write to this register causes the counter to reset and begin counting from the value written. |

**D0F0xE4\_x0132\_80F1 BIOS Timer Control**

Reset: 0000\_0064h.

| Bits    | Description                                                                                                                                                                                                                                                             |      |            |     |                |         |                 |
|---------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------------|-----|----------------|---------|-----------------|
| 31:8    | Reserved.                                                                                                                                                                                                                                                               |      |            |     |                |         |                 |
| 7:0     | <b>ClockRate.</b> Read-write. Specifies the frequency of the reference clock in 1 MHz increments.<br><table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00h</td><td>Timer disabled</td></tr> <tr> <td>FFh-01h</td><td>&lt;ClockRate&gt; MHz</td></tr> </table> | Bits | Definition | 00h | Timer disabled | FFh-01h | <ClockRate> MHz |
| Bits    | Definition                                                                                                                                                                                                                                                              |      |            |     |                |         |                 |
| 00h     | Timer disabled                                                                                                                                                                                                                                                          |      |            |     |                |         |                 |
| FFh-01h | <ClockRate> MHz                                                                                                                                                                                                                                                         |      |            |     |                |         |                 |

**3.3.4 IO Link Registers****Table 108: Mapping for IO link registers**

| D0F0xE0[31:16] | Wrapper | Port Description |
|----------------|---------|------------------|
| 0140h          | PGD     | Gfx+Display      |
| 0141h          | PPD     | GPP+Display      |
| 0142h          | PSD     | FCH+Display      |

**D0F0xE4\_x014[2:0]\_0002 IO Link Hardware Debug**

Reset: 0000\_0000h.

| Bits | Description                                                                                                           |
|------|-----------------------------------------------------------------------------------------------------------------------|
| 31:1 | Reserved.                                                                                                             |
| 0    | <b>HwDebug[0]: ignore DLLPs in L1.</b> Read-write. BIOS: 1. 1=DLLPs are ignored in L1 so the TXCLK can be turned off. |

**D0F0xE4\_x014[2:0]\_0010 IO Link Control 1**

Reset: 80E3\_110Bh.

| Bits  | Description |
|-------|-------------|
| 31:13 | Reserved.   |

|       |                                                                                                                            |                   |             |                   |
|-------|----------------------------------------------------------------------------------------------------------------------------|-------------------|-------------|-------------------|
| 12:10 | <b>RxUmiAdjPayloadSize.</b> Read-write. BIOS: 100b. Payload size for the UMI link.                                         |                   |             |                   |
|       | <u>Bits</u>                                                                                                                | <u>Definition</u> | <u>Bits</u> | <u>Definition</u> |
|       | 00xb                                                                                                                       | Reserved.         | 100b        | 64 bytes          |
|       | 010b                                                                                                                       | 16 bytes          | 101b        | Reserved.         |
|       | 011b                                                                                                                       | 32 bytes.         | 11xb        | Reserved.         |
| 9     | <b>UmiNpMemWrite: memory write mapping enable.</b> Read-write. 1=Internal non-posted memory writes are transferred to UMI. |                   |             |                   |
| 8:4   | Reserved.                                                                                                                  |                   |             |                   |
| 3:1   | <b>LcHotPlugDelSel: enhanced hot plug counter select.</b> Read-write.                                                      |                   |             |                   |
|       | <u>Bits</u>                                                                                                                | <u>Definition</u> | <u>Bits</u> | <u>Definition</u> |
|       | 0h                                                                                                                         | 15 ms             | 4h          | 150 ms            |
|       | 1h                                                                                                                         | 20 ms             | 5h          | 200 ms            |
|       | 2h                                                                                                                         | 50 ms             | 6h          | 275 ms            |
|       | 3h                                                                                                                         | 100 ms            | 7h          | 335 ms            |
| 0     | <b>HwInitWrLock: hardware init write lock.</b> Read-write. 1=Lock HWInit registers. 0=Unlock HWInit registers.             |                   |             |                   |

#### **D0F0xE4\_x014[2:0]\_0011 IO Link Config Control**

Reset: 0000\_000Fh.

| Bits | Description                                                                                                                                                                                                                          |
|------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:4 | Reserved.                                                                                                                                                                                                                            |
| 3:0  | <b>DynClkLatency: dynamic clock latency.</b> Read-write. BIOS: See <a href="#">2.11.4.3.1 [Link Configuration and Core Initialization]</a> . Specifies the number of clock cycles after logic goes idle before clocks are gated off. |

#### **D0F0xE4\_x014[2:0]\_001C IO Link Control 2**

Reset: 0E00\_0109h.

| Bits  | Description                                                                                                                                                                                                                                                                                        |
|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:11 | Reserved.                                                                                                                                                                                                                                                                                          |
| 10:6  | <b>TxArbMstLimit: transmitter arbitration master limit.</b> Read-write. BIOS: 4h. Defines together with TxArbSlvLimit a round robin arbitration pattern for downstream accesses. TxArbMstLimit defines the weight for downstream CPU requests and TxArbSlvLimit for the downstream read responses. |
| 5:1   | <b>TxArbSlvLimit: transmitter arbitration slave limit.</b> Read-write. BIOS: 4h. See TxArbMstLimit for details                                                                                                                                                                                     |
| 0     | <b>TxArbRoundRobinEn: transmitter round robin arbitration enabled.</b> Read-write. BIOS: 1. 1=Enable transmitter round robin arbitration. 0=Disable transmitter round robin arbitration.                                                                                                           |

**D0F0xE4\_x014[2:0]\_0020 IO Link Chip Interface Control**

Reset: 0000\_0050h.

| Bits  | Description                                                                                                                              |
|-------|------------------------------------------------------------------------------------------------------------------------------------------|
| 31:10 | Reserved.                                                                                                                                |
| 9     | <b>CiRcOrderingDis: chip interface RC ordering disable.</b> Read-write. 0=RC ordering logic is enabled. 1=RC ordering logic is disabled. |
| 8:0   | Reserved.                                                                                                                                |

**D0F0xE4\_x014[2:0]\_0040 IO Link Phy Control**

Reset: 0001\_0000h.

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |      |            |     |                                                         |     |                                                         |     |                                                         |     |                                                             |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------------|-----|---------------------------------------------------------|-----|---------------------------------------------------------|-----|---------------------------------------------------------|-----|-------------------------------------------------------------|
| 31:16 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |      |            |     |                                                         |     |                                                         |     |                                                         |     |                                                             |
| 15:14 | <b>PElecIdleMode: electrical idle mode for physical layer.</b> Read-write. BIOS: 11b. Defines which electrical idle signal is used, either inferred by link controller or from phy.<br><table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00b</td><td>Gen1 - entry:PHY, exit:PHY; Gen2 - entry:INF, exit:PHY.</td></tr> <tr> <td>01b</td><td>Gen1 - entry:INF, exit:PHY; Gen2 - entry:INF, exit:PHY.</td></tr> <tr> <td>10b</td><td>Gen1 - entry:PHY, exit:PHY; Gen2 - entry:PHY, exit:PHY.</td></tr> <tr> <td>11b</td><td>Gen1 - entry: PHY, exit: PHY; Gen2 - entry: PHY, exit: PHY.</td></tr> </table> | Bits | Definition | 00b | Gen1 - entry:PHY, exit:PHY; Gen2 - entry:INF, exit:PHY. | 01b | Gen1 - entry:INF, exit:PHY; Gen2 - entry:INF, exit:PHY. | 10b | Gen1 - entry:PHY, exit:PHY; Gen2 - entry:PHY, exit:PHY. | 11b | Gen1 - entry: PHY, exit: PHY; Gen2 - entry: PHY, exit: PHY. |
| Bits  | Definition                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |      |            |     |                                                         |     |                                                         |     |                                                         |     |                                                             |
| 00b   | Gen1 - entry:PHY, exit:PHY; Gen2 - entry:INF, exit:PHY.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |      |            |     |                                                         |     |                                                         |     |                                                         |     |                                                             |
| 01b   | Gen1 - entry:INF, exit:PHY; Gen2 - entry:INF, exit:PHY.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |      |            |     |                                                         |     |                                                         |     |                                                         |     |                                                             |
| 10b   | Gen1 - entry:PHY, exit:PHY; Gen2 - entry:PHY, exit:PHY.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |      |            |     |                                                         |     |                                                         |     |                                                         |     |                                                             |
| 11b   | Gen1 - entry: PHY, exit: PHY; Gen2 - entry: PHY, exit: PHY.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |      |            |     |                                                         |     |                                                         |     |                                                         |     |                                                             |
| 13:0  | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |      |            |     |                                                         |     |                                                         |     |                                                         |     |                                                             |

**D0F0xE4\_x014[2:0]\_00B0 IO Link Strap Control**

Reset: 0000\_8001h.

| Bits | Description                                                                     |
|------|---------------------------------------------------------------------------------|
| 31:6 | Reserved.                                                                       |
| 5    | <b>StrapF0AerEn.</b> Read-write. 1=AER support enabled. 0=AER support disabled. |
| 4:3  | Reserved.                                                                       |
| 2    | <b>StrapF0MsiEn.</b> Read-write. BIOS: 1. Overrides MSI enable.                 |
| 1:0  | Reserved.                                                                       |

**D0F0xE4\_x014[2:0]\_00C0 IO Link Strap Miscellaneous**

| Bits | Description                                   |
|------|-----------------------------------------------|
| 31   | Reserved.                                     |
| 30   | <b>StrapFlrEn.</b> Read-write.                |
| 29   | <b>StrapMstAdr64En.</b> Read-write.           |
| 28   | <b>StrapReverseAll.</b> Read-write. Reset: 0. |
| 27:0 | Reserved.                                     |

**D0F0xE4\_x014[2:0]\_00C1 IO Link Strap Miscellaneous2**

| Bits | Description                                                 |
|------|-------------------------------------------------------------|
| 31:4 | Reserved.                                                   |
| 3    | <b>StrapGen3Compliance</b> . Read-write.                    |
| 2    | Reserved.                                                   |
| 1    | <b>StrapGen2Compliance</b> . Read-write. Reset: 1.          |
| 0    | <b>StrapLinkBwNotificationCapEn</b> . Read-write. Reset: 0. |

**D0F0xF8 Northbridge IOAPIC Index**

Reset: 0000\_0000h. The index/data pair registers, [D0F0xF8](#) and [D0F0xFC](#), are used to access the registers at [D0F0xFC\\_x\[FF:00\]](#). To access any of these registers, the address is first written into the index register, [D0F0xF8](#), and then the data is read from or written to the data register, [D0F0xFC](#).

| Bits | Description                                                       |
|------|-------------------------------------------------------------------|
| 31:8 | Reserved.                                                         |
| 7:0  | <b>IOAPICIndAddr: IOAPIC index register address</b> . Read-write. |

**D0F0xFC Northbridge IOAPIC Data**

Reset: 0000\_0000h. See [D0F0xF8](#). Address: [D0F0xF8](#)[IOAPICIndAddr].

| Bits | Description                                                    |
|------|----------------------------------------------------------------|
| 31:0 | <b>IOAPICIndData: IOAPIC index data register</b> . Read-write. |

**D0F0xFC\_x00 IOAPIC Feature Control Register**

Reset: 0000\_0004h.

| Bits | Description                                                                                                                                                                              |
|------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:9 | Reserved.                                                                                                                                                                                |
| 8:5  | Reserved.                                                                                                                                                                                |
| 4    | <b>IoapicSbFeatureEn</b> . Read-write. 1=Enable masked interrupts to be routed back to the FCH PIC/IOAPIC.                                                                               |
| 3    | Reserved.                                                                                                                                                                                |
| 2    | <b>IoapicIdExtEn</b> . Read-write. Extend the IOAPIC ID from 4-bit to 8-bit. 0=4-bit ID. 1=8-bit ID.                                                                                     |
| 1    | Reserved.                                                                                                                                                                                |
| 0    | <b>IoapicEnable</b> . Read-write. 1=Enables the INTGEN block to decode IOAPIC addresses. BIOS: 1. BIOS should always set this bit after programming the IOAPIC BAR in the init sequence. |

**D0F0xFC\_x01 IOAPIC Base Address Lower**

Reset: FEC0\_0000h. See 3.15 [Northbridge IOAPIC Registers].

| Bits | Description                                                     |
|------|-----------------------------------------------------------------|
| 31:8 | <b>IoapicAddr.</b> Read-write. IOAPIC Base Address bits [31:8]. |
| 7:0  | Reserved.                                                       |

**D0F0xFC\_x02 IOAPIC Base Address Upper**

Reset: 0000\_0000h. See 3.15 [Northbridge IOAPIC Registers].

| Bits | Description                                                           |
|------|-----------------------------------------------------------------------|
| 31:0 | <b>IoapicAddrUpper.</b> Read-write. IOAPIC Base Address bits [63:32]. |

**D0F0xFC\_x0F IOAPIC GBIF Interrupt Routing Register**

Reset: 0000\_0000h.

| Bits | Description                                                                                                                                                                                                                                                                                                                                                   |      |                     |     |      |     |      |     |      |     |      |
|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|---------------------|-----|------|-----|------|-----|------|-----|------|
| 31:6 | Reserved.                                                                                                                                                                                                                                                                                                                                                     |      |                     |     |      |     |      |     |      |     |      |
| 5:4  | <b>GBIFExtIntrSwz.</b> Read-write. Swizzle GBIF INTA/B/C/D based on the value in this field before mapping them onto the IOAPIC pins.<br><table> <tr> <th>Bits</th><th>Interrupt Swizzling</th></tr> <tr> <td>00b</td><td>ABCD</td></tr> <tr> <td>01b</td><td>BCDA</td></tr> <tr> <td>10b</td><td>CDAB</td></tr> <tr> <td>11b</td><td>DABC</td></tr> </table> | Bits | Interrupt Swizzling | 00b | ABCD | 01b | BCDA | 10b | CDAB | 11b | DABC |
| Bits | Interrupt Swizzling                                                                                                                                                                                                                                                                                                                                           |      |                     |     |      |     |      |     |      |     |      |
| 00b  | ABCD                                                                                                                                                                                                                                                                                                                                                          |      |                     |     |      |     |      |     |      |     |      |
| 01b  | BCDA                                                                                                                                                                                                                                                                                                                                                          |      |                     |     |      |     |      |     |      |     |      |
| 10b  | CDAB                                                                                                                                                                                                                                                                                                                                                          |      |                     |     |      |     |      |     |      |     |      |
| 11b  | DABC                                                                                                                                                                                                                                                                                                                                                          |      |                     |     |      |     |      |     |      |     |      |
| 3    | Reserved.                                                                                                                                                                                                                                                                                                                                                     |      |                     |     |      |     |      |     |      |     |      |
| 2:0  | <b>GBIFExtIntrGrp.</b> Read-write. Map GBIF INTA/B/C/D to IOAPIC pins $[(grp+1)*4-1:(grp*4)]$ . For GBIF, only INTA/B are used. INTC/D should be tied off.                                                                                                                                                                                                    |      |                     |     |      |     |      |     |      |     |      |

**D0F0xFC\_x1[B:0] IOAPIC BR Interrupt Routing Register**

Reset: 0000\_0000h.

| Bits  | Description                                                                                 |
|-------|---------------------------------------------------------------------------------------------|
| 31:21 | Reserved.                                                                                   |
| 20:16 | <b>BrIntIntrMap.</b> Read-write. Map bridge n interrupts to IOAPIC redirection table entry. |
| 15:6  | Reserved.                                                                                   |



|             |                                                                                                                                                                                                                                                                                                                                                                                        |             |                            |     |      |     |      |     |      |     |      |
|-------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|----------------------------|-----|------|-----|------|-----|------|-----|------|
| 5:4         | <b>BrExtIntrSwz.</b> Read-write. Swizzle bridge n external INTA/B/C/D based on the value in this field before mapping them onto the IOAPIC pins.<br><table> <tr> <td><u>Bits</u></td><td><u>Interrupt Swizzling</u></td></tr> <tr> <td>00b</td><td>ABCD</td></tr> <tr> <td>01b</td><td>BCDA</td></tr> <tr> <td>10b</td><td>CDAB</td></tr> <tr> <td>11b</td><td>DABC</td></tr> </table> | <u>Bits</u> | <u>Interrupt Swizzling</u> | 00b | ABCD | 01b | BCDA | 10b | CDAB | 11b | DABC |
| <u>Bits</u> | <u>Interrupt Swizzling</u>                                                                                                                                                                                                                                                                                                                                                             |             |                            |     |      |     |      |     |      |     |      |
| 00b         | ABCD                                                                                                                                                                                                                                                                                                                                                                                   |             |                            |     |      |     |      |     |      |     |      |
| 01b         | BCDA                                                                                                                                                                                                                                                                                                                                                                                   |             |                            |     |      |     |      |     |      |     |      |
| 10b         | CDAB                                                                                                                                                                                                                                                                                                                                                                                   |             |                            |     |      |     |      |     |      |     |      |
| 11b         | DABC                                                                                                                                                                                                                                                                                                                                                                                   |             |                            |     |      |     |      |     |      |     |      |
| 3           | Reserved.                                                                                                                                                                                                                                                                                                                                                                              |             |                            |     |      |     |      |     |      |     |      |
| 2:0         | <b>BrExtIntrGrp.</b> Read-write. Map bridge n external INTA/B/C/D to IOAPIC pins $(((grp+1)*4)-1:(grp*4))$ .                                                                                                                                                                                                                                                                           |             |                            |     |      |     |      |     |      |     |      |

#### D0F0xFC\_x30 IOAPIC Serial IRQ Status

Reset: 0000\_0000h.

| Bits | Description                                                                         |
|------|-------------------------------------------------------------------------------------|
| 31:0 | <b>InternallrqSts.</b> Read-only. Shows the status of the 32 IOAPIC interrupt pins. |

#### D0F0xFC\_x3[F:E] IOAPIC Scratch [1:0] Register

Reset: 0000\_0000h.

| Bits | Description                 |
|------|-----------------------------|
| 31:0 | <b>Scratch.</b> Read-write. |

### 3.4 Device 0 Function 2 (IOMMU) Configuration Registers

See 3.1 [Register Descriptions and Mnemonics]. See 2.7 [Configuration Space]. See 2.12.1 [IOMMU Configuration Space].

#### D0F2x00 Device/Vendor ID

| Bits  | Description                                          |
|-------|------------------------------------------------------|
| 31:16 | <b>DeviceID: device ID.</b> Read-only. Value: 1423h. |
| 15:0  | <b>VendorID: vendor ID.</b> Read-only. Value: 1022h. |

#### D0F2x04 Status/Command

| Bits  | Description                                                                                      |
|-------|--------------------------------------------------------------------------------------------------|
| 31    | <b>ParityErrorDetected.</b> Read; write-1-to-clear. Reset: 0.                                    |
| 30    | <b>SignaledSystemError.</b> Read-only. Reset: 0.                                                 |
| 29    | <b>ReceivedMasterAbort.</b> Read; write-1-to-clear. Reset: 0.                                    |
| 28    | <b>ReceivedTargetAbort.</b> Read; write-1-to-clear. Reset: 0.                                    |
| 27    | <b>SignalTargetAbort.</b> Read-only. Reset: 0.                                                   |
| 26:25 | Reserved.                                                                                        |
| 24    | <b>MasterDataError.</b> Read; write-1-to-clear. Reset: 0.                                        |
| 23:21 | Reserved.                                                                                        |
| 20    | <b>CapList.</b> Read-only. Reset: 1. 1=Capability list supported.                                |
| 19    | <b>IntStatus.</b> Read-only. Reset: 0. 1=INTx message pending.                                   |
| 18:11 | Reserved.                                                                                        |
| 10    | <b>InterruptDis.</b> Read-write. Reset: 0. 1=INTx interrupt message generation disabled.         |
| 9     | Reserved.                                                                                        |
| 8     | <b>SerrEn.</b> Read-only. Reset: 0. 1=Enables reporting of non-fatal and fatal errors detected.  |
| 7     | Reserved.                                                                                        |
| 6     | <b>ParityErrorEn.</b> Read-write. Reset: 0. 1=Enables setting of ParityErrorDetected status bit. |
| 5:3   | Reserved.                                                                                        |
| 2     | <b>BusMasterEn.</b> Read-write. Reset: 0. 1=Enables DMA request generation.                      |
| 1     | <b>MemAccessEn.</b> Read-only. Reset: 0.                                                         |
| 0     | <b>IoAccessEn.</b> Read-only. Reset: 0.                                                          |

**D0F2x08 Class Code/Revision ID**

Reset: 0806\_00xxh.

| Bits | Description                                                                                                 |
|------|-------------------------------------------------------------------------------------------------------------|
| 31:8 | <b>ClassCode: class code.</b> Read-only. Provides the IOMMU class code as defined in the PCI specification. |
| 7:0  | <b>RevID: revision ID.</b> Read-only.                                                                       |

**D0F2x0C Header Type**

Reset: 0080\_0000h.

| Bits  | Description                                                        |
|-------|--------------------------------------------------------------------|
| 31:24 | <b>BIST.</b> Read-only.                                            |
| 23:16 | <b>HeaderTypeReg.</b> Read-only. 80h=Type 0 multi-function device. |
| 15:8  | <b>LatencyTimer.</b> Read-write.                                   |
| 7:0   | <b>CacheLineSize.</b> Read-only.                                   |

**D0F2x2C Subsystem and Subvendor ID**

| Bits  | Description                              |
|-------|------------------------------------------|
| 31:16 | <b>SubsystemId.</b><br>Value: 1423h.     |
| 15:0  | <b>SubsystemVendorId.</b> Value: 1022h . |

**D0F2x34 Capabilities Pointer**

| Bits | Description                           |
|------|---------------------------------------|
| 31:8 | Reserved.                             |
| 7:0  | <b>CapPtr.</b> Read-only. Reset: 40h. |

**D0F2x3C Interrupt Line**

| Bits  | Description |
|-------|-------------|
| 31:16 | Reserved.   |

| 15:8    | <b>InterruptPin.</b> Read-only. Reset: 01h. This field indicates the INTx line used to generate legacy interrupts.<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00h</td><td>Reserved.</td></tr> <tr> <td>01h</td><td>INTA.</td></tr> <tr> <td>02h</td><td>INTB.</td></tr> <tr> <td>03h</td><td>INTC.</td></tr> <tr> <td>04h</td><td>INTD.</td></tr> <tr> <td>FFh-05h</td><td>Reserved.</td></tr> </table> | Bits | Description | 00h | Reserved. | 01h | INTA. | 02h | INTB. | 03h | INTC. | 04h | INTD. | FFh-05h | Reserved. |
|---------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|-----|-----------|-----|-------|-----|-------|-----|-------|-----|-------|---------|-----------|
| Bits    | Description                                                                                                                                                                                                                                                                                                                                                                                                                  |      |             |     |           |     |       |     |       |     |       |     |       |         |           |
| 00h     | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                    |      |             |     |           |     |       |     |       |     |       |     |       |         |           |
| 01h     | INTA.                                                                                                                                                                                                                                                                                                                                                                                                                        |      |             |     |           |     |       |     |       |     |       |     |       |         |           |
| 02h     | INTB.                                                                                                                                                                                                                                                                                                                                                                                                                        |      |             |     |           |     |       |     |       |     |       |     |       |         |           |
| 03h     | INTC.                                                                                                                                                                                                                                                                                                                                                                                                                        |      |             |     |           |     |       |     |       |     |       |     |       |         |           |
| 04h     | INTD.                                                                                                                                                                                                                                                                                                                                                                                                                        |      |             |     |           |     |       |     |       |     |       |     |       |         |           |
| FFh-05h | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                    |      |             |     |           |     |       |     |       |     |       |     |       |         |           |
| 7:0     | <b>InterruptLine.</b> Read-write. Reset: 0. This field is read/write for software compatibility. It controls no hardware.                                                                                                                                                                                                                                                                                                    |      |             |     |           |     |       |     |       |     |       |     |       |         |           |

### D0F2x40 IOMMU Capability

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:28 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 27    | <b>IommuEfrSup.</b> Read-only. Reset: 1. 1=Indicates <a href="#">IOMMUx30 [Extended Feature Low]</a> is supported. 0= <a href="#">IOMMUx30</a> is reserved.                                                                                                                                                                                                                                                                                 |
| 26    | <b>IommuNpCache.</b> Read-only. Reset: 0. 1=Indicates that the IOMMU caches page table entries that are marked as not present. When this bit is set, software must issue an invalidate after any change to a PDE or PTE. 0=Indicates that the IOMMU caches only page table entries that are marked as present. When this bit is clear, software must issue an invalidate after any change to a PDE or PTE marked present before the change. |
| 25    | <b>IommuHtTunnelSup.</b> Read-only. Reset: 0.                                                                                                                                                                                                                                                                                                                                                                                               |
| 24    | <b>IommuIoTlbsup.</b> Read-only. Reset: 1. Indicates support for remote IOTLBs. .                                                                                                                                                                                                                                                                                                                                                           |
| 23:19 | <b>IommuCapRev.</b> Read-only. Reset: 1. Specifies the IOMMU interface revision.                                                                                                                                                                                                                                                                                                                                                            |
| 18:16 | <b>IommuCapType.</b> Read-only. Reset: 3h. Specifies the layout of the Capability Block as an IOMMU capability block.                                                                                                                                                                                                                                                                                                                       |
| 15:8  | <b>IommuCapPtr.</b> Read-only. Reset: 54h. Indicates the location of the next capability block.                                                                                                                                                                                                                                                                                                                                             |
| 7:0   | <b>IommuCapId.</b> Read-only. Reset: Fh. Indicates a Secure Device capability block.                                                                                                                                                                                                                                                                                                                                                        |

### D0F2x44 IOMMU Base Address Low

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                          |
|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:14 | <b>IommuBaseAddr[31:14]: IOMMU base address bits[31:14].</b> IF (D0F2x44[IommuEnable]) THEN Read-only. ELSE Read-write. ENDIF. Reset: 0. IommuBaseAddr[63:14] = {D0F2x48[IommuBaseAddr[63:32]], IommuBaseAddr[31:14]}. IommuBaseAddr[63:14] specifies the base address of the IOMMU memory mapped control registers. In order to use the IOMMU event counters, IommuBaseAddr[18:14] must be 0_0000b. |
| 13:1  | Reserved.                                                                                                                                                                                                                                                                                                                                                                                            |
| 0     | <b>IommuEnable.</b> Read; write-1-only. Reset: 0. 1=IOMMU accepts memory accesses to the address specified in IommuBaseAddr[63:14]. When this bit is set, all IOMMU RW capability registers in PCI configuration space are locked.                                                                                                                                                                   |

**D0F2x48 IOMMU Base Address High**

| Bits | Description                                                                                                       |
|------|-------------------------------------------------------------------------------------------------------------------|
| 31:0 | <b>IommuBaseAddr[63:32]: IOMMU base address bits[63:32].</b> See: <a href="#">D0F2x44</a> [IommuBaseAddr[31:14]]. |

**D0F2x4C IOMMU Range**

| Bits  | Description                                                                                                                                                                                                                                                              |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:24 | <b>IommuLastDevice.</b> Read-only. Reset: 0. Indicates device and function number of the last integrated device associated with the IOMMU.                                                                                                                               |
| 23:16 | <b>IommuFirstDevice.</b> Read-only. Reset: 0. Indicates device and function number of the first integrated device associated with the IOMMU.                                                                                                                             |
| 15:8  | <b>IommuBusNumber.</b> Read-only. Reset: 0. Indicates the bus number that IommuLastDevice and IommuFirstDevice reside on.                                                                                                                                                |
| 7     | <b>IommuRngValid.</b> Read-only. Reset: 0. 1=The IommuBusNumber, IommuFirstDevice, and IommuLastDevice fields are valid. Although the register contents are valid, software is encouraged to use I/O topology information. 0=Software must use I/O topology information. |
| 6:5   | Reserved.                                                                                                                                                                                                                                                                |
| 4:0   | <b>IommuUnitId.</b> Read-only. Reset: 0.                                                                                                                                                                                                                                 |

**D0F2x50 IOMMU Miscellaneous Information Register**

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                   |
|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:27 | <b>IommuMsiNumPpr.</b> Read-only. Reset: 0. This field must indicate which MSI vector is used for the interrupt message generated by the IOMMU for the peripheral page service request log when <a href="#">IOMMUx30</a> [PprSup]=1. This field must be 0 when <a href="#">IOMMUx30</a> [PprSup]=0. For MSI there can be only one IOMMU so this field must be 0. This interrupt is not remapped by the IOMMU. |
| 26:23 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                     |
| 22    | <b>IommuHtAtsResv.</b> IF ( <a href="#">D0F2x44</a> [IommuEnable]) THEN Read-only. ELSE Read-write. ENDIF. Reset: 0. 1=The link Address Translation address range for ATS responses is reserved and cannot be translated by the IOMMU. 0=The Address Translation address range can be translated by the IOMMU.                                                                                                |

| 21:15     | <p><b>IommuVaSize.</b> Read-only. Reset: 40h. This field must indicate the size of the maximum virtual address processed by the IOMMU. The value is the (unsigned) binary log of the maximum address size.</p> <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>19h-00h</td><td>Reserved.</td></tr> <tr> <td>20h</td><td>32 bits.</td></tr> <tr> <td>27h-21h</td><td>Reserved.</td></tr> <tr> <td>28h</td><td>40 bits.</td></tr> <tr> <td>2Fh-29h</td><td>Reserved.</td></tr> <tr> <td>30h</td><td>48 bits.</td></tr> <tr> <td>3Fh-31h</td><td>Reserved.</td></tr> <tr> <td>40h</td><td>64 bits.</td></tr> <tr> <td>7Fh-41h</td><td>Reserved.</td></tr> </table> | Bits | Description | 19h-00h   | Reserved. | 20h  | 32 bits. | 27h-21h   | Reserved. | 28h | 40 bits.  | 2Fh-29h | Reserved. | 30h     | 48 bits.  | 3Fh-31h | Reserved. | 40h | 64 bits. | 7Fh-41h | Reserved. |
|-----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|-----------|-----------|------|----------|-----------|-----------|-----|-----------|---------|-----------|---------|-----------|---------|-----------|-----|----------|---------|-----------|
| Bits      | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |      |             |           |           |      |          |           |           |     |           |         |           |         |           |         |           |     |          |         |           |
| 19h-00h   | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |      |             |           |           |      |          |           |           |     |           |         |           |         |           |         |           |     |          |         |           |
| 20h       | 32 bits.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |      |             |           |           |      |          |           |           |     |           |         |           |         |           |         |           |     |          |         |           |
| 27h-21h   | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |      |             |           |           |      |          |           |           |     |           |         |           |         |           |         |           |     |          |         |           |
| 28h       | 40 bits.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |      |             |           |           |      |          |           |           |     |           |         |           |         |           |         |           |     |          |         |           |
| 2Fh-29h   | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |      |             |           |           |      |          |           |           |     |           |         |           |         |           |         |           |     |          |         |           |
| 30h       | 48 bits.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |      |             |           |           |      |          |           |           |     |           |         |           |         |           |         |           |     |          |         |           |
| 3Fh-31h   | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |      |             |           |           |      |          |           |           |     |           |         |           |         |           |         |           |     |          |         |           |
| 40h       | 64 bits.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |      |             |           |           |      |          |           |           |     |           |         |           |         |           |         |           |     |          |         |           |
| 7Fh-41h   | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |      |             |           |           |      |          |           |           |     |           |         |           |         |           |         |           |     |          |         |           |
| 14:8      | <p><b>IommuPaSize.</b> Read-only. Reset: 30h. This field must indicate the size of the maximum physical address generated by the IOMMU. The value is the (unsigned) binary log of the maximum address size.</p> <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>27h-00h</td><td>Reserved.</td></tr> <tr> <td>28h</td><td>40 bits.</td></tr> <tr> <td>7Fh-29h</td><td>Reserved.</td></tr> <tr> <td>29h</td><td>Reserved.</td></tr> <tr> <td>30h</td><td>48 bits.</td></tr> <tr> <td>7Fh-31h</td><td>Reserved.</td></tr> </table>                                                                                                                                 | Bits | Description | 27h-00h   | Reserved. | 28h  | 40 bits. | 7Fh-29h   | Reserved. | 29h | Reserved. | 30h     | 48 bits.  | 7Fh-31h | Reserved. |         |           |     |          |         |           |
| Bits      | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |      |             |           |           |      |          |           |           |     |           |         |           |         |           |         |           |     |          |         |           |
| 27h-00h   | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |      |             |           |           |      |          |           |           |     |           |         |           |         |           |         |           |     |          |         |           |
| 28h       | 40 bits.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |      |             |           |           |      |          |           |           |     |           |         |           |         |           |         |           |     |          |         |           |
| 7Fh-29h   | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |      |             |           |           |      |          |           |           |     |           |         |           |         |           |         |           |     |          |         |           |
| 29h       | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |      |             |           |           |      |          |           |           |     |           |         |           |         |           |         |           |     |          |         |           |
| 30h       | 48 bits.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |      |             |           |           |      |          |           |           |     |           |         |           |         |           |         |           |     |          |         |           |
| 7Fh-31h   | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |      |             |           |           |      |          |           |           |     |           |         |           |         |           |         |           |     |          |         |           |
| 7:5       | <p><b>IommuGvaSize.</b> Read-only. Reset: 010b. Indicates the size of the maximum guest virtual address processed by the IOMMU.</p> <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>001b-000b</td><td>Reserved.</td></tr> <tr> <td>010b</td><td>48 bits.</td></tr> <tr> <td>111b-011b</td><td>Reserved.</td></tr> </table>                                                                                                                                                                                                                                                                                                                                      | Bits | Description | 001b-000b | Reserved. | 010b | 48 bits. | 111b-011b | Reserved. |     |           |         |           |         |           |         |           |     |          |         |           |
| Bits      | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |      |             |           |           |      |          |           |           |     |           |         |           |         |           |         |           |     |          |         |           |
| 001b-000b | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |      |             |           |           |      |          |           |           |     |           |         |           |         |           |         |           |     |          |         |           |
| 010b      | 48 bits.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |      |             |           |           |      |          |           |           |     |           |         |           |         |           |         |           |     |          |         |           |
| 111b-011b | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |      |             |           |           |      |          |           |           |     |           |         |           |         |           |         |           |     |          |         |           |
| 4:0       | <p><b>IommuMsiNum.</b> Read-only. Reset: 0. Indicates the MSI vector used for interrupt messages generated by the IOMMU.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |      |             |           |           |      |          |           |           |     |           |         |           |         |           |         |           |     |          |         |           |

#### D0F2x54 IOMMU MSI Capability Register

| Bits  | Description                                                                                                      |
|-------|------------------------------------------------------------------------------------------------------------------|
| 31:24 | Reserved.                                                                                                        |
| 23    | <b>Msi64En.</b> Read-only. Reset: 1. 1=64-bit MSI addressing is supported                                        |
| 22:20 | <b>MsiMultMessEn.</b> Read-write. Reset: 0. Specifies the number of MSI messages assigned to this function.      |
| 19:17 | <b>MsiMultMessCap.</b> Read-only. Reset: 0. Specifies the number of MSI messages requested by this function.     |
| 16    | <b>MsiEn.</b> Read-write. Reset: 0. 1=Enables MSI for this function and causes legacy interrupts to be disabled. |
| 15:8  | <b>MsiCapPtr.</b> Read-only. Reset: 64h. Pointer to the next capability register offset.                         |
| 7:0   | <b>MsiCapId.</b> Read-only. Reset: 5h. Indicates that this is the MSI capability.                                |

**D0F2x58 IOMMU MSI Address Low**

| Bits | Description                                                                                                             |
|------|-------------------------------------------------------------------------------------------------------------------------|
| 31:2 | <b>MsiAddr[31:2]</b> . Read-write. Reset: 0. This register specifies the lower address bits used to issue MSI messages. |
| 1:0  | Reserved.                                                                                                               |

**D0F2x5C IOMMU MSI Address High**

| Bits | Description                                                                                                              |
|------|--------------------------------------------------------------------------------------------------------------------------|
| 31:0 | <b>MsiAddr[63:32]</b> . Read-write. Reset: 0. This register specifies the upper address bits used to issue MSI messages. |

**D0F2x60 IOMMU MSI Data**

| Bits  | Description                                                                                       |
|-------|---------------------------------------------------------------------------------------------------|
| 31:16 | Reserved.                                                                                         |
| 15:0  | <b>MsiData</b> . Read-write. Reset: 0. This register specifies the data issued with MSI messages. |

**D0F2x64 IOMMU MSI Mapping Capability**

| Bits  | Description                                                                                                          |
|-------|----------------------------------------------------------------------------------------------------------------------|
| 31:27 | <b>MsiMapCapType</b> . Read-only. Reset: 15h. Indicates the MSI Mapping Capability.                                  |
| 26:18 | Reserved.                                                                                                            |
| 17    | <b>MsiMapFixd</b> . Read-only. Reset: 1. 1=MSI interrupt mapping range is not programmable.                          |
| 16    | <b>MsiMapEn</b> . Read-only. Reset: 1. Always set to 1 to indicate that the MSI Mapping Capability is always enabled |
| 15:8  | <b>MsiMapCapPtr</b> . Read-only. Reset: 0. Points to the next capability list item                                   |
| 7:0   | <b>MsiMapCapId</b> . Read-only. Reset: 8h. Indicates a link capability list item                                     |

**D0F2x6C IOMMU Control**

| Bits  | Description                                                                                                    |
|-------|----------------------------------------------------------------------------------------------------------------|
| 31:14 | Reserved.                                                                                                      |
| 13    | <b>CapExtW</b> . Read-write. Reset: 1. This field sets the value of <a href="#">D0F2x40</a> [IommuCapExt].     |
| 12:10 | <b>MsiMultMessCapW</b> . Read-write. Reset: 2h.                                                                |
| 9     | <b>EfrSupW</b> . Read-write. Reset: 1. This field sets the value of <a href="#">D0F2x40</a> [IommuEfrSup].     |
| 8     | <b>IoTlbsupW</b> . Read-write. Reset: 1. This field sets the value of <a href="#">D0F2x40</a> [IommuIoTlbsup]. |
| 7:4   | <b>MinorRevIdW</b> . Read-write. Reset: 0. This field sets the value of <a href="#">D0F2x08</a> [RevID[3:0]].  |

|     |                                                                                                                   |
|-----|-------------------------------------------------------------------------------------------------------------------|
| 3   | Reserved.                                                                                                         |
| 2:0 | <b>InterruptPinW</b> . Read-write. Reset: 1. This field sets the value of <a href="#">D0F2x3C</a> [InterruptPin]. |

### D0F2x70 IOMMU MMIO Control Low

| Bits  | Description                                                                                                                                                                                                   |
|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:18 | Reserved.                                                                                                                                                                                                     |
| 17:16 | <b>SmifSupW</b> . Read-write. Reset: 0.                                                                                                                                                                       |
| 15:12 | Reserved.                                                                                                                                                                                                     |
| 11:10 | <b>HatsW</b> . Read-write. Reset: 2h. This field sets the value of <a href="#">IOMMUx30</a> [HATS].                                                                                                           |
| 9     | <b>PcSupW</b> . Read-write. Reset: 1. This field sets the value of <a href="#">IOMMUx30</a> [PcSup].                                                                                                          |
| 8     | Reserved.                                                                                                                                                                                                     |
| 7     | Reserved.                                                                                                                                                                                                     |
| 6     | <b>IaSupW</b> . Read-write. Reset: 1. This field sets the value of <a href="#">IOMMUx30</a> [IaSup].                                                                                                          |
| 5     | Reserved.                                                                                                                                                                                                     |
| 4     | <b>GtSupW</b> . Read-write. Reset: 1. This field sets the value of <a href="#">IOMMUx30</a> [GtSup].                                                                                                          |
| 3     | <b>NxSupW</b> . Read-write. Reset: 0. This field sets the value of <a href="#">IOMMUx30</a> [NxSup]. BIOS: Program <a href="#">D0F2xFC_x07_L1i</a> [4:0][ForceNoExePerm]=1 when <a href="#">NxSupW</a> ==0b_. |
| 2     | Reserved.                                                                                                                                                                                                     |
| 1     | <b>PprSupW</b> . Read-write. Reset: 1. This field sets the value of <a href="#">IOMMUx30</a> [PprSup].                                                                                                        |
| 0     | <b>PrefSupW</b> . Read-write. Reset: 1. BIOS: 0. This field sets the value of <a href="#">IOMMUx30</a> [PrefSup].                                                                                             |

### D0F2x74 IOMMU MMIO Control High

| Bits | Description                                                                                             |
|------|---------------------------------------------------------------------------------------------------------|
| 31:4 | Reserved.                                                                                               |
| 3:0  | <b>PasMaxW</b> . Read-write. Reset: 8h. This field sets the value of <a href="#">IOMMUx34</a> [PasMax]. |

### D0F2x78 IOMMU Range Control

The fields in this register set the values of the corresponding fields in [D0F2x4C](#).

| Bits  | Description                                 |
|-------|---------------------------------------------|
| 31:24 | <b>LastDeviceW</b> . Read-write. Reset: 0.  |
| 23:16 | <b>FirstDeviceW</b> . Read-write. Reset: 0. |
| 15:8  | <b>BusNumberW</b> . Read-write. Reset: 0.   |
| 7     | <b>RngValidW</b> . Read-write. Reset: 0.    |
| 6:0   | Reserved.                                   |

### D0F2xF0 IOMMU L2 Config Index

The index/data pair registers, [D0F2xF0](#) and [D0F2xF4](#) are used to access the registers at [D0F2xF4\\_x](#)[FF:00].



To access any of these registers, the address is first written into the index register, [D0F2xF0](#), and then the data is read from or written to the data register, [D0F2xF4](#). See [2.12.1 \[IOMMU Configuration Space\]](#).

| Bits | Description                               |
|------|-------------------------------------------|
| 31:9 | Reserved.                                 |
| 8    | <b>L2cfgWrEn</b> . Read-write. Reset: 0.  |
| 7:0  | <b>L2cfgIndex</b> . Read-write. Reset: 0. |

#### **D0F2xF4 IOMMU L2 Config Data**

IF ([D0F2xF0](#)[L2cfgWrEn]) THEN Read-write. ELSE Read-only. Reset: 0000\_0000h. See [D0F2xF0](#). Address: [D0F2xF0](#)[L2cfgIndex].

| Bits | Description        |
|------|--------------------|
| 31:0 | <b>L2cfgData</b> . |

#### **D0F2xF4\_x00 L2\_PERF\_CNTL\_0**

| Bits  | Description                                                                                               |
|-------|-----------------------------------------------------------------------------------------------------------|
| 31:24 | <b>L2PerfCountUpper1</b> . Read-only. Reset: 0. Upper 8 bits of IOMMU L2 performance counter 1            |
| 23:16 | <b>L2PerfCountUpper0</b> . Read-only. Reset: 0. Upper 8 bits of IOMMU L2 performance counter 0            |
| 15:8  | <b>L2PerfEvent1</b> . Read-write. Reset: 0. Selects the IOMMU L2 performance counter event for counter 1. |
| 7:0   | <b>L2PerfEvent0</b> . Read-write. Reset: 0. Selects the IOMMU L2 performance counter event for counter 0. |

#### **D0F2xF4\_x01 L2\_PERF\_COUNT\_0**

| Bits | Description                                                                                 |
|------|---------------------------------------------------------------------------------------------|
| 31:0 | <b>L2PerfCount0</b> . Read-only. Reset: 0. Lower 32 bits of IOMMU L2 performance counter 0. |

#### **D0F2xF4\_x02 L2\_PERF\_COUNT\_1**

| Bits | Description                                                                                 |
|------|---------------------------------------------------------------------------------------------|
| 31:0 | <b>L2PerfCount1</b> . Read-only. Reset: 0. Lower 32 bits of IOMMU L2 performance counter 1. |

#### **D0F2xF4\_x03 L2\_PERF\_CNTL\_1**

| Bits  | Description                                                                                     |
|-------|-------------------------------------------------------------------------------------------------|
| 31:24 | <b>L2PerfCountUpper3</b> . Read-only. Reset: 0. Upper 8 bits of IOMMU L2 performance counter 3. |
| 23:16 | <b>L2PerfCountUpper2</b> . Read-only. Reset: 0. Upper 8 bits of IOMMU L2 performance counter 2. |

|      |                                                                                                           |
|------|-----------------------------------------------------------------------------------------------------------|
| 15:8 | <b>L2PerfEvent3</b> . Read-write. Reset: 0. Selects the IOMMU L2 performance counter event for counter 3. |
| 7:0  | <b>L2PerfEvent2</b> . Read-write. Reset: 0. Selects the IOMMU L2 performance counter event for counter 2. |

**D0F2xF4\_x04 L2\_PERF\_COUNT\_2**

| Bits | Description                                                                                 |
|------|---------------------------------------------------------------------------------------------|
| 31:0 | <b>L2PerfCount2</b> . Read-only. Reset: 0. Lower 32 bits of IOMMU L2 performance counter 2. |

**D0F2xF4\_x05 L2\_PERF\_COUNT\_3**

| Bits | Description                                                                                 |
|------|---------------------------------------------------------------------------------------------|
| 31:0 | <b>L2PerfCount3</b> . Read-only. Reset: 0. Lower 32 bits of IOMMU L2 performance counter 3. |

**D0F2xF4\_x08 L2\_STATUS\_0**

| Bits | Description                                                        |
|------|--------------------------------------------------------------------|
| 31:0 | <b>L2STATUS0</b> . Read-only. Reset: 0. Internal IOMMU L2A status. |

**D0F2xF4\_x0C L2\_CONTROL\_0**

| Bits  | Description                                                                                                                                                                                                                                                                            |
|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:24 | <b>IFifoClientPriority</b> . Read-write. Reset: 0. Each bit of this register controls whether the corresponding L1 client is arbitrated as high priority or not. Not all implementations will use all of the priority bits due to a lower number of clients versus the register width. |
| 23:20 | <b>IFifoBurstLength</b> . Read-write. Reset: 1. Sets the burst length when arbitrating between clients coming into the L2.                                                                                                                                                             |
| 19    | Reserved.                                                                                                                                                                                                                                                                              |
| 18    | <b>FLTCMBPriority</b> . Read-write. Reset: 0. 0=Round-robin arbitration between cache responses and table-walker responses at the fault combiner. . 1=Table-walker responses always win arbitration at the fault combiner.                                                             |
| 17:12 | <b>IFifoCMBCredits</b> . Read-write. Reset: 4h. Controls the initial number of credits for the ififo to fault/CMB interface. Credits are loaded whenever the register value changes. This register may only be programmed when IOMMU is not enabled to preserve correct operation.     |
| 11    | <b>SIDEPTEOnAddrTransExcl</b> . Read-write. Reset: 0. 0=Caches return DTE to L1 on an address translation exclusion range access. 1=Caches return PTE to L1 on an address translation exclusion range access.                                                                          |
| 10    | <b>SIDEPTEOnUntransExcl</b> . Read-write. Reset: 0. 0=Caches return DTE to L1 on an untranslated exclusion range access . 1=Caches return PTE to L1 on an untranslated exclusion range access.                                                                                         |
| 9:4   | <b>IFifoTWCredits</b> . Read-write. Reset: 4h. Controls the initial number of credits for the ififo to TW interface. Credits are loaded whenever the register changes value. This register may only be programmed when IOMMU is not enabled to preserve correct operation.             |

|   |                                                                                                                                                                                                                                                                                                          |
|---|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 3 | <b>DTCHitVZeroOrIVZero.</b> Read-write. Reset: 0. 0=A DTE is refetched if a DTE with V=0 for a memory request or IV=1 for an interrupt request is hit in the DTC . 1=A DTE is not refetched if a DTE with V=0 for a memory request or IV=1 for an interrupt request is hit in the DTC. This DTE is used. |
| 2 | <b>AllowL1CacheATSRsp.</b> Read-write. Reset: 0. 0=L2 does not allow L1 to cache responses to ATS address translation requests . 1=L2 allows L1 to cache responses to ATS address translation requests.                                                                                                  |
| 1 | <b>AllowL1CacheVZero.</b> Read-write. Reset: 0. 0=L2 does not allow L1 to cache DTEs where V=0 . 1=L2 allows L1 to cache DTEs where V=1. L1 stores IR and IW as if they are both set to 1.                                                                                                               |
| 0 | <b>PTCAddrTransReqCheck.</b> Read-write. Reset: 0. 0=Address translation requests do not check the PTC . 1=Address translation requests check the PTC.                                                                                                                                                   |

### D0F2xF4\_x0D L2\_CONTROL\_1

| Bits  | Description                                                                                                                                                                                                                                                                                       |
|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:24 | <b>PerfThreshold.</b> Read-write. Reset: 0. Fifo threshold level used to calculate certain performance counter values.                                                                                                                                                                            |
| 23:17 | Reserved.                                                                                                                                                                                                                                                                                         |
| 16    | <b>SeqInvBurstLimitEn.</b> Read-write. Reset: 1. Enable stalling L2 requests to allow invalidation cycles to make forward progress based upon SeqInvBurstLimitInv and SeqInvBurstLimitL2Req.                                                                                                      |
| 15:8  | <b>SeqInvBurstLimitL2Req.</b> Read-write. Reset: 8h. Sets the number of consecutive IOMMU L2 requests to perform when doing sequential invalidation. Regular L2 and invalidation requests will alternate access to the main L2 caches based upon SeqInvBurstLimitInv and SeqInvBurstLimitL2Req.   |
| 7:0   | <b>SeqInvBurstLimitInv.</b> Read-write. Reset: 8h. Sets the number of consecutive invalidation requests to perform when doing sequential invalidation. Regular L2 and invalidation requests will alternate access to the main L2 caches based upon SeqInvBurstLimitInv and SeqInvBurstLimitL2Req. |

### D0F2xF4\_x10 L2\_DTC\_CONTROL

| Bits  | Description                                                                                                                        |
|-------|------------------------------------------------------------------------------------------------------------------------------------|
| 31:28 | <b>DTCEntries.</b> Read-only. Reset: 0. The number of entries in the DTC is indicated as 2^DTCEntries.                             |
| 27:24 | Reserved.                                                                                                                          |
| 23:16 | <b>DTCWays.</b> Read-only. Reset: 0. Indicates the number of ways in the DTC.                                                      |
| 15    | <b>DTCParitySupport.</b> Read-only. Reset: 0. 0=The DTC does not support parity protection . 1=The DTC supports parity protection. |
| 14    | Reserved.                                                                                                                          |
| 13    | <b>DTCBypass.</b> Read-write. Reset: 0. When set, all requests bypass the DTC.                                                     |
| 12:11 | Reserved.                                                                                                                          |
| 10    | <b>DTCSoftInvalidate.</b> Read-write. Reset: 0. Software may write this register to 1 to invalidate all entries in the DTC.        |

|             |                                                                                                                                                                                                                                                                   |
|-------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 9:8         | <b>DTCInvalidationSel.</b> Read-write. Reset: 0. BIOS: 10b. Selects the DTC invalidation algorithm.                                                                                                                                                               |
| <u>Bits</u> | <u>Description</u>                                                                                                                                                                                                                                                |
| 00b         | Invalidate the entire DTC.                                                                                                                                                                                                                                        |
| 01b         | Fast imprecise invalidation.                                                                                                                                                                                                                                      |
| 10b         | Sequential precise invalidation.                                                                                                                                                                                                                                  |
| 11b         | Partial sequential precise invalidation.                                                                                                                                                                                                                          |
| 7:5         | Reserved.                                                                                                                                                                                                                                                         |
| 4           | <b>DTCParityEn.</b> Read-write. Reset: 0. Enable parity protection of the DTC.                                                                                                                                                                                    |
| 3           | <b>DTCLRUUpdatePri.</b> Read-write. Reset: 0. 0=Reads update replacement state bits when there is a simultaneous read and write to the same DTC index . 1=Writes update replacement state bits when there is a simultaneous read and write to the same DTC index. |
| 2           | Reserved.                                                                                                                                                                                                                                                         |
| 1:0         | <b>DTCReplacementSel.</b> Read-write. Reset: 1. Selects the DTC replacement algorithm. Implementation may not support all replacement algorithms.                                                                                                                 |

#### D0F2xF4\_x11 L2\_DTC\_HASH\_CONTROL

| Bits  | Description                                                                                                                                                                                                                                                                            |
|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:16 | <b>DtcAddressMask.</b> Read-write. Reset: 0h. This field is a bit-wise AND mask that selects which bits from the untranslated interrupt {MT[2:0],Vector} are used to index into the DTC.                                                                                               |
| 15:11 | Reserved.                                                                                                                                                                                                                                                                              |
| 10    | <b>DtcAltHashEn.</b> Read-write. Reset: 0. Enable alternative algorithm for generating hash index into the DTC.                                                                                                                                                                        |
| 9     | Reserved.                                                                                                                                                                                                                                                                              |
| 8:5   | <b>DTCBusBits.</b> Read-write. Reset: 3h. Set the number of bus bits to use when using ReqID to form the DTC address. The following equation must be satisfied. $\text{Func\_bits} + \text{Dev\_Bits} + \text{Bus\_Bits} \leq \log_2(\text{DTC entries} / \text{DTC associativity})$ . |
| 4:2   | <b>DTCDevBits.</b> Read-write. Reset: 0. Set the number of device bits to use when using ReqID to form the DTC address.                                                                                                                                                                |
| 1:0   | <b>DTCFuncBits.</b> Read-write. Reset: 2h. Set the number of function bits to use when using ReqID to form the DTC address.                                                                                                                                                            |

#### D0F2xF4\_x12 L2\_DTC\_WAY\_CONTROL

| Bits  | Description                                                                                                                                                                                                                                       |
|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:16 | <b>DTCWayAccessDisable.</b> Read-write. Reset: 0.                                                                                                                                                                                                 |
| 15:0  | <b>DTCWayDisable.</b> Read-write. Reset: 0. Each bit in this register disables a way in the DTC when set to 1. An implementation may have less than 32 ways. The entire cache may be disabled by setting the DTCWays lower bits of this register. |

**D0F2xF4\_x14 L2\_ITC\_CONTROL**

| Bits  | Description                                                                                                                                                                                                                                                       |
|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:28 | <b>ITCEntries</b> . Read-only. Reset: 0. The number of entries in the ITC is indicated as $2^{\text{ITCEntries}}$ .                                                                                                                                               |
| 27:24 | Reserved.                                                                                                                                                                                                                                                         |
| 23:16 | <b>ITCWays</b> . Read-only. Reset: 0. Indicates the number of ways in the ITC.                                                                                                                                                                                    |
| 15    | <b>ITCParitySupport</b> . Read-only. Reset: 0. 0=The ITC does not support parity protection . 1=The ITC supports parity protection.                                                                                                                               |
| 14    | Reserved.                                                                                                                                                                                                                                                         |
| 13    | <b>ITCBypass</b> . Read-write. Reset: 0. When set, all requests bypass the ITC.                                                                                                                                                                                   |
| 12:11 | Reserved.                                                                                                                                                                                                                                                         |
| 10    | <b>ITCSoftInvalidate</b> . Read-write. Reset: 0. Software may write this register to 1 to invalidate all entries in the ITC.                                                                                                                                      |
| 9:8   | <b>ITCInvalidationSel</b> . Read-write. Reset: 0. BIOS: See 2.12.2. Selects the ITC invalidation algorithm.                                                                                                                                                       |
| Bits  | Description                                                                                                                                                                                                                                                       |
| 00b   | Invalidate the entire ITC.                                                                                                                                                                                                                                        |
| 01b   | Fast imprecise invalidation.                                                                                                                                                                                                                                      |
| 10b   | Sequential precise invalidation.                                                                                                                                                                                                                                  |
| 11b   | Partial sequential precise invalidation                                                                                                                                                                                                                           |
| 7:5   | Reserved.                                                                                                                                                                                                                                                         |
| 4     | <b>ITCParityEn</b> . Read-write. Reset: 0. Enable parity protection of the ITC.                                                                                                                                                                                   |
| 3     | <b>ITCLRUpdatePri</b> . Read-write. Reset: 0. 0=Reads update replacement state bits when there is a simultaneous read and write to the same ITC index . 1=Writes update replacement state bits when there is a simultaneous read and write to the same ITC index. |
| 2     | Reserved.                                                                                                                                                                                                                                                         |
| 1:0   | <b>ITCReplacementSel</b> . Read-write. Reset: 1. Selects the ITC replacement algorithm. Implementation may not support all replacement algorithms.                                                                                                                |

**D0F2xF4\_x15 L2\_ITC\_HASH\_CONTROL**

| Bits  | Description                                                                                                                                                                                                                                                                             |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:16 | <b>ITCAddressMask</b> . Read-write. Reset: 0h. This register is a bit-wise AND mask that selects which bits from the untranslated interrupt {MT[2:0],Vector} are used to index into the ITC.                                                                                            |
| 15:11 | Reserved.                                                                                                                                                                                                                                                                               |
| 10    | <b>ItcAltHashEn</b> . Read-write. Reset: 0. Enable alternative algorithm for generating hash index into the ITC.                                                                                                                                                                        |
| 9     | Reserved.                                                                                                                                                                                                                                                                               |
| 8:5   | <b>ITCBusBits</b> . Read-write. Reset: 3h. Set the number of bus bits to use when using ReqID to form the ITC address. The following equation must be satisfied. $\text{Func\_bits} + \text{Dev\_Bits} + \text{Bus\_Bits} \leq \log_2(\text{ITC entries} / \text{ITC associativity})$ . |

|     |                                                                                                                              |
|-----|------------------------------------------------------------------------------------------------------------------------------|
| 4:2 | <b>ITCDevBits</b> . Read-write. Reset: 0. Set the number of device bits to use when using ReqID to form the ITC address.     |
| 1:0 | <b>ITCFuncBits</b> . Read-write. Reset: 2h. Set the number of function bits to use when using ReqID to form the ITC address. |

**D0F2xF4\_x16 L2\_ITC\_WAY\_CONTROL**

| Bits  | Description                                                                                                                                                                                                                                        |
|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:16 | <b>ITCWayAccessDisable</b> . Read-write. Reset: 0.                                                                                                                                                                                                 |
| 15:0  | <b>ITCWayDisable</b> . Read-write. Reset: 0. Each bit in this register disables a way in the ITC when set to 1. An implementation may have less than 32 ways. The entire cache may be disabled by setting the ITCWays lower bits of this register. |

**D0F2xF4\_x18 L2\_PTC\_A\_CONTROL**

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                        |      |             |     |                                        |     |                              |     |                                  |     |                                          |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|-----|----------------------------------------|-----|------------------------------|-----|----------------------------------|-----|------------------------------------------|
| 31:28 | <b>PTCAEntries</b> . Read-only. Reset: 0. The number of entries in the PTC A sub-cache is indicated as $2^{\text{PTCAEntries}}$                                                                                                                                                                                                                                                                                                                                    |      |             |     |                                        |     |                              |     |                                  |     |                                          |
| 27:24 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                          |      |             |     |                                        |     |                              |     |                                  |     |                                          |
| 23:16 | <b>PTCAWays</b> . Read-only. Reset: 0. Indicates the number of ways in the PTC A sub-cache                                                                                                                                                                                                                                                                                                                                                                         |      |             |     |                                        |     |                              |     |                                  |     |                                          |
| 15    | <b>PTCAParitySupport</b> . Read-only. Reset: 0. 0=The PTC A sub-cache does not support parity protection. 1=The PTC A sub-cache supports parity protection                                                                                                                                                                                                                                                                                                         |      |             |     |                                        |     |                              |     |                                  |     |                                          |
| 14    | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                          |      |             |     |                                        |     |                              |     |                                  |     |                                          |
| 13    | <b>PTCABypass</b> . Read-write. Reset: 0. When set, all requests bypass the PTC A sub-cache.                                                                                                                                                                                                                                                                                                                                                                       |      |             |     |                                        |     |                              |     |                                  |     |                                          |
| 12    | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                          |      |             |     |                                        |     |                              |     |                                  |     |                                          |
| 11    | <b>PTCA2MMode</b> . Read-write. Reset: 0. When set, the PTC A sub-cache stores 2M pages instead of 4K pages                                                                                                                                                                                                                                                                                                                                                        |      |             |     |                                        |     |                              |     |                                  |     |                                          |
| 10    | <b>PTCASoftInvalidate</b> . Read-write. Reset: 0. Software may write this register to 1 to invalidate all entries in the PTC A sub-cache                                                                                                                                                                                                                                                                                                                           |      |             |     |                                        |     |                              |     |                                  |     |                                          |
| 9:8   | <b>PTCAInvalidationSel</b> . Read-write. Reset: 0. BIOS: See 2.12.2. Selects the PTC A sub-cache invalidation algorithm.<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>Invalidate the entire PTC A sub-cache.</td></tr> <tr> <td>01b</td><td>Fast imprecise invalidation.</td></tr> <tr> <td>10b</td><td>Sequential precise invalidation.</td></tr> <tr> <td>11b</td><td>Partial sequential precise invalidation.</td></tr> </table> | Bits | Description | 00b | Invalidate the entire PTC A sub-cache. | 01b | Fast imprecise invalidation. | 10b | Sequential precise invalidation. | 11b | Partial sequential precise invalidation. |
| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                        |      |             |     |                                        |     |                              |     |                                  |     |                                          |
| 00b   | Invalidate the entire PTC A sub-cache.                                                                                                                                                                                                                                                                                                                                                                                                                             |      |             |     |                                        |     |                              |     |                                  |     |                                          |
| 01b   | Fast imprecise invalidation.                                                                                                                                                                                                                                                                                                                                                                                                                                       |      |             |     |                                        |     |                              |     |                                  |     |                                          |
| 10b   | Sequential precise invalidation.                                                                                                                                                                                                                                                                                                                                                                                                                                   |      |             |     |                                        |     |                              |     |                                  |     |                                          |
| 11b   | Partial sequential precise invalidation.                                                                                                                                                                                                                                                                                                                                                                                                                           |      |             |     |                                        |     |                              |     |                                  |     |                                          |
| 7:5   | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                          |      |             |     |                                        |     |                              |     |                                  |     |                                          |
| 4     | <b>PTCAParityEn</b> . Read-write. Reset: 0. Enable parity protection of the PTC A sub-cache                                                                                                                                                                                                                                                                                                                                                                        |      |             |     |                                        |     |                              |     |                                  |     |                                          |
| 3     | <b>PTCALRUUpdatePri</b> . Read-write. Reset: 0. 0=Reads update replacement state bits when there is a simultaneous read and write to the same PTCA index. 1=Writes update replacement state bits when there is a simultaneous read and write to the same PTCA index                                                                                                                                                                                                |      |             |     |                                        |     |                              |     |                                  |     |                                          |

|     |                                                                                                                                                               |
|-----|---------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 2   | Reserved.                                                                                                                                                     |
| 1:0 | <b>PTCAReplacementSel.</b> Read-write. Reset: 1. Selects the PTC A sub-cache replacement algorithm. Implementation may not support all replacement algorithms |

#### D0F2xF4\_x19 L2\_PTC\_A\_HASH\_CONTROL

| Bits  | Description                                                                                                                                                                                                                                                                                                           |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:16 | <b>PTCAAddressMask.</b> Read-write. Reset: 0h. This register is a bit-wise AND mask that selects which virtual address bits are used to index into the PTC A sub-cache.                                                                                                                                               |
| 15:11 | Reserved.                                                                                                                                                                                                                                                                                                             |
| 10    | <b>PtcAltHashEn.</b> Read-write. Reset: 0. Enable alternative algorithm for generating hash index into the PTC.                                                                                                                                                                                                       |
| 9     | Reserved.                                                                                                                                                                                                                                                                                                             |
| 8:5   | <b>PTCABusBits.</b> Read-write. Reset: 3h. Set the number of bus bits to use when using ReqID to form the PTC A sub-cache address. The following equation must be satisfied. $\text{FuncBits} + \text{DevBits} + \text{BusBits} \leq \log_2(\text{PTC A sub-cache entries} / \text{PTC A sub-cache associativity})$ . |
| 4:2   | <b>PTCDevBits.</b> Read-write. Reset: 0. Set the number of device bits to use when using ReqID to form the PTC A sub-cache address.                                                                                                                                                                                   |
| 1:0   | <b>PTCAFuncBits.</b> Read-write. Reset: 2h. Set the number of function bits to use when using ReqID to form the PTC A sub-cache address.                                                                                                                                                                              |

#### D0F2xF4\_x1A L2\_PTC\_A\_WAY\_CONTROL

| Bits  | Description                                                                                                                                                                                                                                                     |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:16 | <b>PTCAWayAccessDisable.</b> Read-write. Reset: 0.                                                                                                                                                                                                              |
| 15:0  | <b>PTCAWayDisable.</b> Read-write. Reset: 0. Each bit in this register disables a way in the PTC A sub-cache when set to 1. An implementation may have less than 32 ways. The entire cache may be disabled by setting the PTCAWays lower bits of this register. |

#### D0F2xF4\_x1C L2\_PTC\_B\_CONTROL

| Bits  | Description                                                                                                                                               |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:28 | <b>PTCBEentries.</b> Read-only. Reset: 0. The number of entries in the PTC B sub-cache is indicated as $2^{\text{PTCBEentries}}$                          |
| 27:24 | Reserved.                                                                                                                                                 |
| 23:16 | <b>PTCBWays.</b> Read-only. Reset: 0. Indicates the number of ways in the PTC B sub-cache                                                                 |
| 15    | <b>PTCBParitySupport.</b> Read-only. Reset: 0. 0=The PTC B sub-cache does not support parity protection. 1=The PTC B sub-cache supports parity protection |
| 14    | Reserved.                                                                                                                                                 |
| 13    | <b>PTCBBypass.</b> Read-write. Reset: 0. When set, all requests bypass the PTC B sub-cache.                                                               |
| 12    | Reserved.                                                                                                                                                 |

| 11   | <b>PTCB2MMode.</b> Read-write. Reset: 0. When set, the PTCB sub-cache stores 2M pages instead of 4K pages.                                                                                                                                                                                                                                                                                                                                      |      |             |     |                                        |     |                              |     |                                  |     |                                          |
|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|-----|----------------------------------------|-----|------------------------------|-----|----------------------------------|-----|------------------------------------------|
| 10   | <b>PTCBSoftInvalidate.</b> Read-write. Reset: 0. Software may write this register to 1 to invalidate all entries in the PTC B sub-cache                                                                                                                                                                                                                                                                                                         |      |             |     |                                        |     |                              |     |                                  |     |                                          |
| 9:8  | <b>PTCBInvalidationSel.</b> Read-write. Reset: 0. Selects the PTC B sub-cache invalidation algorithm.<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>Invalidate the entire PTC B sub-cache.</td></tr> <tr> <td>01b</td><td>Fast imprecise invalidation.</td></tr> <tr> <td>10b</td><td>Sequential precise invalidation.</td></tr> <tr> <td>11b</td><td>Partial sequential precise invalidation.</td></tr> </table> | Bits | Description | 00b | Invalidate the entire PTC B sub-cache. | 01b | Fast imprecise invalidation. | 10b | Sequential precise invalidation. | 11b | Partial sequential precise invalidation. |
| Bits | Description                                                                                                                                                                                                                                                                                                                                                                                                                                     |      |             |     |                                        |     |                              |     |                                  |     |                                          |
| 00b  | Invalidate the entire PTC B sub-cache.                                                                                                                                                                                                                                                                                                                                                                                                          |      |             |     |                                        |     |                              |     |                                  |     |                                          |
| 01b  | Fast imprecise invalidation.                                                                                                                                                                                                                                                                                                                                                                                                                    |      |             |     |                                        |     |                              |     |                                  |     |                                          |
| 10b  | Sequential precise invalidation.                                                                                                                                                                                                                                                                                                                                                                                                                |      |             |     |                                        |     |                              |     |                                  |     |                                          |
| 11b  | Partial sequential precise invalidation.                                                                                                                                                                                                                                                                                                                                                                                                        |      |             |     |                                        |     |                              |     |                                  |     |                                          |
| 7:5  | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                       |      |             |     |                                        |     |                              |     |                                  |     |                                          |
| 4    | <b>PTCBParityEn.</b> Read-write. Reset: 0. Enable parity protection of the PTC B sub-cache                                                                                                                                                                                                                                                                                                                                                      |      |             |     |                                        |     |                              |     |                                  |     |                                          |
| 3    | <b>PTCBLRUUpdatePri.</b> Read-write. Reset: 0. 0=Reads update replacement state bits when there is a simultaneous read and write to the same PTCB index . 1=Writes update replacement state bits when there is a simultaneous read and write to the same PTCB index                                                                                                                                                                             |      |             |     |                                        |     |                              |     |                                  |     |                                          |
| 2    | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                       |      |             |     |                                        |     |                              |     |                                  |     |                                          |
| 1:0  | <b>PTCBReplacementSel.</b> Read-write. Reset: 1. Selects the PTC B sub-cache replacement algorithm. Implementation may not support all replacement algorithms                                                                                                                                                                                                                                                                                   |      |             |     |                                        |     |                              |     |                                  |     |                                          |

#### D0F2xF4\_x1D L2\_PTC\_B\_HASH\_CONTROL

| Bits  | Description                                                                                                                                                                                                                                                                                                           |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:16 | <b>PTCBAddressMask.</b> Read-write. Reset: 0h. This register is a bit-wise AND mask that selects which virtual address bits are used to index into the PTC B sub-cache.                                                                                                                                               |
| 15:9  | Reserved.                                                                                                                                                                                                                                                                                                             |
| 8:5   | <b>PTCBBusBits.</b> Read-write. Reset: 3h. Set the number of bus bits to use when using ReqID to form the PTC B sub-cache address. The following equation must be satisfied. $\text{FuncBits} + \text{DevBits} + \text{BusBits} \leq \log_2(\text{PTC B sub-cache entries} / \text{PTC B sub-cache associativity})$ . |
| 4:2   | <b>PTCBDevBits.</b> Read-write. Reset: 0. Set the number of device bits to use when using ReqID to form the PTC B sub-cache address.                                                                                                                                                                                  |
| 1:0   | <b>PTCBFuncBits.</b> Read-write. Reset: 2h. Set the number of function bits to use when using ReqID to form the PTC B sub-cache address.                                                                                                                                                                              |

#### D0F2xF4\_x1E L2\_PTC\_B\_WAY\_CONTROL

| Bits  | Description                                                                                                                                                                                                                                                     |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:16 | <b>PTCBWayAccessDisable.</b> Read-write. Reset: 0.                                                                                                                                                                                                              |
| 15:0  | <b>PTCBWayDisable.</b> Read-write. Reset: 0. Each bit in this register disables a way in the PTC A sub-cache when set to 1. An implementation may have less than 32 ways. The entire cache may be disabled by setting the PTCBWays lower bits of this register. |



**D0F2xF4\_x20 L2\_CREDIT\_CONTROL\_2**

| Bits  | Description                                                                                                                                                                                    |
|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:28 | Reserved.                                                                                                                                                                                      |
| 27:24 | <b>PprLoggerCredits</b> . Read-write. Reset: 4h. PPR log buffer credit override value.                                                                                                         |
| 23    | <b>FCELOverride</b> . Read-write. Reset: 0. Changing this register from 0 to 1 overrides the FCEL credit counter with FCELCredits. This should only be performed when the IOMMU is idle.       |
| 22    | Reserved.                                                                                                                                                                                      |
| 21:16 | <b>FCELCredits</b> . Read-write. Reset: 0. FCEL credit override value.                                                                                                                         |
| 15    | <b>FLTCMBOverride</b> . Read-write. Reset: 0. Changing this register from 0 to 1 overrides the FLTCMB credit counter with FLTCMBCredits. This should only be performed when the IOMMU is idle. |
| 14    | Reserved.                                                                                                                                                                                      |
| 13:8  | <b>FLTCMBCredits</b> . Read-write. Reset: 0. FLTCMB credit override value                                                                                                                      |
| 7     | <b>QUEUEOverride</b> . Read-write. Reset: 0. Changing this register from 0 to 1 overrides the QUEUE credit counter with QUEUECredits. This should only be performed when the IOMMU is idle     |
| 6     | Reserved.                                                                                                                                                                                      |
| 5:0   | <b>QUEUECredits</b> . Read-write. Reset: 0. QUEUE credit override value                                                                                                                        |

**D0F2xF4\_x22 L2A\_UPDATE\_FILTER\_CNTL**

| Bits | Description                                                                                                                                                                                          |
|------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:5 | Reserved.                                                                                                                                                                                            |
| 4:1  | <b>L2aUpdateFilterRdlatency</b> . Read-write. Reset: 3h. When L2a_Update_Filter_Bypass is 0, assume the invalidation read has completed in the number of clock cycles specified by this field.       |
| 0    | <b>L2aUpdateFilterBypass</b> . Read-write. Reset: 1. 1=Disable duplicate update filtering. 0=Enable the dropping of updates that are already in the L2aUpdateFilter or in the destination L2a cache. |

**D0F2xF4\_x30 L2\_ERR\_RULE\_CONTROL\_3**

| Bits | Description                                                                                                                                                                                      |
|------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:4 | <b>ERRRuleDisable3</b> . Read-write. Reset: 0. Each bit in this register disables an error detection rule in the IOMMU.                                                                          |
| 3:1  | Reserved.                                                                                                                                                                                        |
| 0    | <b>ERRRuleLock1</b> . Read-write. Reset: 0. BIOS: See <a href="#">2.12.2</a> . This register is write-once. Setting this register bit locks the error detection rule set in ERRRuleDisable3/4/5. |

**D0F2xF4\_x31 L2\_ERR\_RULE\_CONTROL\_4**

| Bits | Description                                                                                                             |
|------|-------------------------------------------------------------------------------------------------------------------------|
| 31:0 | <b>ERRRuleDisable4</b> . Read-write. Reset: 0. Each bit in this register disables an error detection rule in the IOMMU. |

**D0F2xF4\_x32 L2\_ERR\_RULE\_CONTROL\_5**

| Bits | Description                                                                                                             |
|------|-------------------------------------------------------------------------------------------------------------------------|
| 31:0 | <b>ERRRuleDisable5</b> . Read-write. Reset: 0. Each bit in this register disables an error detection rule in the IOMMU. |

**D0F2xF4\_x33 L2\_L2A\_CK\_GATE\_CONTROL**

| Bits | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |      |             |     |                                                                                |     |                                                                                |     |                                                                                |     |                                                                                 |
|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|-----|--------------------------------------------------------------------------------|-----|--------------------------------------------------------------------------------|-----|--------------------------------------------------------------------------------|-----|---------------------------------------------------------------------------------|
| 31:8 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |      |             |     |                                                                                |     |                                                                                |     |                                                                                |     |                                                                                 |
| 7:6  | <b>CKGateL2AStop</b> . Read-write. Reset: 01b.<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>Allow 2 clock cycles delay before stopping the clocks when clkready deasserts.</td></tr> <tr> <td>01b</td><td>Allow 4 clock cycles delay before stopping the clocks when clkready deasserts.</td></tr> <tr> <td>10b</td><td>Allow 8 clock cycles delay before stopping the clocks when clkready deasserts.</td></tr> <tr> <td>11b</td><td>Allow 16 clock cycles delay before stopping the clocks when clkready deasserts.</td></tr> </table> | Bits | Description | 00b | Allow 2 clock cycles delay before stopping the clocks when clkready deasserts. | 01b | Allow 4 clock cycles delay before stopping the clocks when clkready deasserts. | 10b | Allow 8 clock cycles delay before stopping the clocks when clkready deasserts. | 11b | Allow 16 clock cycles delay before stopping the clocks when clkready deasserts. |
| Bits | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |      |             |     |                                                                                |     |                                                                                |     |                                                                                |     |                                                                                 |
| 00b  | Allow 2 clock cycles delay before stopping the clocks when clkready deasserts.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |      |             |     |                                                                                |     |                                                                                |     |                                                                                |     |                                                                                 |
| 01b  | Allow 4 clock cycles delay before stopping the clocks when clkready deasserts.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |      |             |     |                                                                                |     |                                                                                |     |                                                                                |     |                                                                                 |
| 10b  | Allow 8 clock cycles delay before stopping the clocks when clkready deasserts.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |      |             |     |                                                                                |     |                                                                                |     |                                                                                |     |                                                                                 |
| 11b  | Allow 16 clock cycles delay before stopping the clocks when clkready deasserts.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |      |             |     |                                                                                |     |                                                                                |     |                                                                                |     |                                                                                 |
| 5:4  | <b>CKGateL2ALength</b> . Read-write. Reset: 01b.<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>Allow 128 clock cycles delay before stopping the clocks when idle asserts.</td></tr> <tr> <td>01b</td><td>Allow 256 clock cycles delay before stopping the clocks when idle asserts.</td></tr> <tr> <td>10b</td><td>Allow 512 clock cycles delay before stopping the clocks when idle asserts.</td></tr> <tr> <td>11b</td><td>Allow 1024 clock cycles delay before stopping the clocks when idle asserts.</td></tr> </table>               | Bits | Description | 00b | Allow 128 clock cycles delay before stopping the clocks when idle asserts.     | 01b | Allow 256 clock cycles delay before stopping the clocks when idle asserts.     | 10b | Allow 512 clock cycles delay before stopping the clocks when idle asserts.     | 11b | Allow 1024 clock cycles delay before stopping the clocks when idle asserts.     |
| Bits | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |      |             |     |                                                                                |     |                                                                                |     |                                                                                |     |                                                                                 |
| 00b  | Allow 128 clock cycles delay before stopping the clocks when idle asserts.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |      |             |     |                                                                                |     |                                                                                |     |                                                                                |     |                                                                                 |
| 01b  | Allow 256 clock cycles delay before stopping the clocks when idle asserts.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |      |             |     |                                                                                |     |                                                                                |     |                                                                                |     |                                                                                 |
| 10b  | Allow 512 clock cycles delay before stopping the clocks when idle asserts.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |      |             |     |                                                                                |     |                                                                                |     |                                                                                |     |                                                                                 |
| 11b  | Allow 1024 clock cycles delay before stopping the clocks when idle asserts.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |      |             |     |                                                                                |     |                                                                                |     |                                                                                |     |                                                                                 |
| 3    | <b>CKGateL2ASpare</b> . Read-write. Reset: 0. Spare bit.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |      |             |     |                                                                                |     |                                                                                |     |                                                                                |     |                                                                                 |
| 2    | <b>CKGateL2ACacheDisable</b> . Read-write. Reset: 1. BIOS: 0. 1=Disable the gating of the l2b upper cache ways.                                                                                                                                                                                                                                                                                                                                                                                                                                                         |      |             |     |                                                                                |     |                                                                                |     |                                                                                |     |                                                                                 |
| 1    | <b>CKGateL2ADynamicDisable</b> . Read-write. Reset: 1. BIOS: 0. 1=Disable the gating of the l2b dynamic clock branch.                                                                                                                                                                                                                                                                                                                                                                                                                                                   |      |             |     |                                                                                |     |                                                                                |     |                                                                                |     |                                                                                 |
| 0    | <b>CKGateL2ARegsDisable</b> . Read-write. Reset: 1. BIOS: 0. 1=Disable the gating of the l2b register clock branch.                                                                                                                                                                                                                                                                                                                                                                                                                                                     |      |             |     |                                                                                |     |                                                                                |     |                                                                                |     |                                                                                 |

**D0F2xF4\_x34 L2\_L2A\_PGFSIZE\_CONTROL**

| Bits | Description                                                                      |
|------|----------------------------------------------------------------------------------|
| 31:4 | Reserved.                                                                        |
| 3:2  | <b>L2aregHostPgsz</b> . Read-write. Reset: 0. BIOS: See <a href="#">2.12.2</a> . |
| 1:0  | <b>L2aregGstPgsz</b> . Read-write. Reset: 0. BIOS: See <a href="#">2.12.2</a> .  |

**D0F2xF4\_x3B IOMMU\_PGFSM\_CONFIG**

| Bits  | Description                                                                                      |
|-------|--------------------------------------------------------------------------------------------------|
| 31:28 | <b>RegAddr</b> . Read-write. Reset: 0. Indicate the register address for write or read operation |
| 27    | <b>SrbmOverride</b> . Read-write. Reset: 0.                                                      |

|       |                                                                                                         |
|-------|---------------------------------------------------------------------------------------------------------|
| 26:14 | Reserved.                                                                                               |
| 13    | <b>PGRead.</b> Read-write. Reset: 0. Indicate a read operation is performed                             |
| 12    | <b>PGWrite.</b> Read-write. Reset: 0. Indicate a write operation is performed                           |
| 11    | Reserved.                                                                                               |
| 10    | <b>P1Select.</b> Read-write. Reset: 0. Indicate the power up or down is for P1 domain                   |
| 9     | <b>PowerUp.</b> Read-write. Reset: 0. Request power up                                                  |
| 8     | <b>PowerDown.</b> Read-write. Reset: 0. Request power down                                              |
| 7:0   | <b>FsmAddr.</b> Read-write. Reset: 0. Indicate the address of the PGFSM. 0xFFh = broadcast to all PGFSM |

#### **D0F2xF4\_x3C IOMMU\_PGFSM\_WRITE**

| Bits | Description                              |
|------|------------------------------------------|
| 31:0 | <b>WriteValue.</b> Read-write. Reset: 0. |

#### **D0F2xF4\_x3D IOMMU\_PGFSM\_READ**

| Bits  | Description                            |
|-------|----------------------------------------|
| 31:24 | Reserved.                              |
| 23:0  | <b>ReadValue.</b> Read-only. Reset: 0. |

#### **D0F2xF4\_x40 L2\_PERF\_CNTL\_2**

| Bits  | Description                                                                                             |
|-------|---------------------------------------------------------------------------------------------------------|
| 31:24 | <b>L2PerfCountUpper5.</b> Read-only. Reset: 0. Upper 8 bits of IOMMU L2 performance counter 5           |
| 23:16 | <b>L2PerfCountUpper4.</b> Read-only. Reset: 0. Upper 8 bits of IOMMU L2 performance counter 4           |
| 15:8  | <b>L2PerfEvent5.</b> Read-write. Reset: 0. Selects the IOMMU L2 performance counter event for counter 5 |
| 7:0   | <b>L2PerfEvent4.</b> Read-write. Reset: 0. Selects the IOMMU L2 performance counter event for counter 4 |

#### **D0F2xF4\_x41 L2\_PERF\_COUNT\_4**

| Bits | Description                                                                               |
|------|-------------------------------------------------------------------------------------------|
| 31:0 | <b>L2PerfCount4.</b> Read-only. Reset: 0. Lower 32 bits of IOMMU L2 performance counter 4 |

#### **D0F2xF4\_x42 L2\_PERF\_COUNT\_5**

| Bits | Description                                                                               |
|------|-------------------------------------------------------------------------------------------|
| 31:0 | <b>L2PerfCount5.</b> Read-only. Reset: 0. Lower 32 bits of IOMMU L2 performance counter 5 |

**D0F2xF4\_x43 L2\_PERF\_CNTL\_3**

| Bits  | Description                                                                                              |
|-------|----------------------------------------------------------------------------------------------------------|
| 31:24 | <b>L2PerfCountUpper7</b> . Read-only. Reset: 0. Upper 8 bits of IOMMU L2 performance counter 7           |
| 23:16 | <b>L2PerfCountUpper6</b> . Read-only. Reset: 0. Upper 8 bits of IOMMU L2 performance counter 6           |
| 15:8  | <b>L2PerfEvent7</b> . Read-write. Reset: 0. Selects the IOMMU L2 performance counter event for counter 7 |
| 7:0   | <b>L2PerfEvent6</b> . Read-write. Reset: 0. Selects the IOMMU L2 performance counter event for counter 6 |

**D0F2xF4\_x44 L2\_PERF\_COUNT\_6**

| Bits | Description                                                                                |
|------|--------------------------------------------------------------------------------------------|
| 31:0 | <b>L2PerfCount6</b> . Read-only. Reset: 0. Lower 32 bits of IOMMU L2 performance counter 6 |

**D0F2xF4\_x45 L2\_PERF\_COUNT\_7**

| Bits | Description                                                                                |
|------|--------------------------------------------------------------------------------------------|
| 31:0 | <b>L2PerfCount7</b> . Read-only. Reset: 0. Lower 32 bits of IOMMU L2 performance counter 7 |

**D0F2xF4\_x46 L2\_DEBUG\_2**

| Bits | Description                             |
|------|-----------------------------------------|
| 31:0 | <b>L2DEBUG2</b> . Read-write. Reset: 0. |

**D0F2xF4\_x47 L2\_DEBUG\_3**

| Bits | Description                                                                                      |
|------|--------------------------------------------------------------------------------------------------|
| 31:3 | Reserved.                                                                                        |
| 2    | <b>TwAtomicFilterEn</b> . Read-write. Reset: 0. BIOS: 1. 1=Enable table walker atomic filtering. |
| 1    | <b>TwNwEn</b> . Read-write. Reset: 0. BIOS: 1. 1=Enable NW bit for ATS requests.                 |
| 0    | Reserved.                                                                                        |

**D0F2xF4\_x48 L2\_STATUS\_1**

| Bits | Description                                                       |
|------|-------------------------------------------------------------------|
| 31:0 | <b>L2STATUS1</b> . Read-only. Reset: 0. Internal IOMMU L2B status |

**D0F2xF4\_x49 L2\_SB\_LOCATION**

| Bits       | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |            |                     |     |                                                                         |     |                                                         |     |                                                         |     |                                                         |        |           |
|------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|---------------------|-----|-------------------------------------------------------------------------|-----|---------------------------------------------------------|-----|---------------------------------------------------------|-----|---------------------------------------------------------|--------|-----------|
| 31:16      | <b>SbLocatedCore.</b> Read-write. Reset: 0. Specifies the core location of the FCH.<br><table> <tr> <td><u>Bit</u></td><td><u>PortLocation</u></td></tr> <tr> <td>[0]</td><td>FCH is located under GPP0</td></tr> <tr> <td>[1]</td><td>FCH is located under GPP1</td></tr> <tr> <td>[2]</td><td>FCH is located under GPP2</td></tr> <tr> <td>[3]</td><td>FCH is located under GPP3</td></tr> <tr> <td>[15:4]</td><td>Reserved.</td></tr> </table>                                                                                                                                                                                                   | <u>Bit</u> | <u>PortLocation</u> | [0] | FCH is located under GPP0                                               | [1] | FCH is located under GPP1                               | [2] | FCH is located under GPP2                               | [3] | FCH is located under GPP3                               | [15:4] | Reserved. |
| <u>Bit</u> | <u>PortLocation</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |            |                     |     |                                                                         |     |                                                         |     |                                                         |     |                                                         |        |           |
| [0]        | FCH is located under GPP0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |            |                     |     |                                                                         |     |                                                         |     |                                                         |     |                                                         |        |           |
| [1]        | FCH is located under GPP1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |            |                     |     |                                                                         |     |                                                         |     |                                                         |     |                                                         |        |           |
| [2]        | FCH is located under GPP2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |            |                     |     |                                                                         |     |                                                         |     |                                                         |     |                                                         |        |           |
| [3]        | FCH is located under GPP3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |            |                     |     |                                                                         |     |                                                         |     |                                                         |     |                                                         |        |           |
| [15:4]     | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |            |                     |     |                                                                         |     |                                                         |     |                                                         |     |                                                         |        |           |
| 15:0       | <b>SbLocatedPort.</b> Read-write. Reset: 0. BIOS: See <a href="#">2.12.2 [IOMMU Initialization]</a> . Specifies the port location of the FCH.<br><table> <tr> <td><u>Bit</u></td><td><u>PortLocation</u></td></tr> <tr> <td>[0]</td><td>FCH is located on port A of the corresponding PCIe core or internal FCH</td></tr> <tr> <td>[1]</td><td>FCH is located on port B of the corresponding PCIe core</td></tr> <tr> <td>[2]</td><td>FCH is located on port C of the corresponding PCIe core</td></tr> <tr> <td>[3]</td><td>FCH is located on port D of the corresponding PCIe core</td></tr> <tr> <td>[15:4]</td><td>Reserved.</td></tr> </table> | <u>Bit</u> | <u>PortLocation</u> | [0] | FCH is located on port A of the corresponding PCIe core or internal FCH | [1] | FCH is located on port B of the corresponding PCIe core | [2] | FCH is located on port C of the corresponding PCIe core | [3] | FCH is located on port D of the corresponding PCIe core | [15:4] | Reserved. |
| <u>Bit</u> | <u>PortLocation</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |            |                     |     |                                                                         |     |                                                         |     |                                                         |     |                                                         |        |           |
| [0]        | FCH is located on port A of the corresponding PCIe core or internal FCH                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |            |                     |     |                                                                         |     |                                                         |     |                                                         |     |                                                         |        |           |
| [1]        | FCH is located on port B of the corresponding PCIe core                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |            |                     |     |                                                                         |     |                                                         |     |                                                         |     |                                                         |        |           |
| [2]        | FCH is located on port C of the corresponding PCIe core                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |            |                     |     |                                                                         |     |                                                         |     |                                                         |     |                                                         |        |           |
| [3]        | FCH is located on port D of the corresponding PCIe core                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |            |                     |     |                                                                         |     |                                                         |     |                                                         |     |                                                         |        |           |
| [15:4]     | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |            |                     |     |                                                                         |     |                                                         |     |                                                         |     |                                                         |        |           |

**D0F2xF4\_x4C L2\_CONTROL\_5**

| Bits  | Description                                                                                                                                                                                                                  |
|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:10 | Reserved.                                                                                                                                                                                                                    |
| 9:8   | <b>GstPartialPtcCntrl.</b> Read-write. Reset: 0. BIOS: 11b.                                                                                                                                                                  |
| 7     | <b>FC2AltMode.</b> Read-write. Reset: 0. 0=FC2 primary flow-control mode. 1=FC2 alternate flow-control mode.                                                                                                                 |
| 6     | <b>FC3Dis.</b> Read-write. Reset: 0. 0=FC3 flow-control loop is enabled. 1=FC3 flow-control loop is disabled.                                                                                                                |
| 5     | <b>FC2Dis.</b> Read-write. Reset: 0. 0=FC2 flow-control loop is enabled. 1=FC2 flow-control loop is disabled.                                                                                                                |
| 4     | <b>DTCUpdateVZeroIVOne.</b> Read-write. Reset: 0. 0=DTEs with V=0 and IV=1 are not cached in the DTC. 1=DTEs with V=0 and IV=1 are cached in the DTC.                                                                        |
| 3     | <b>DTCUpdateVOneIVZero.</b> Read-write. Reset: 0. 0=DTEs with V=1 and IV=0 are not cached in the DTC. 1=DTEs with V=1 and IV=0 are cached in the DTC.                                                                        |
| 2     | <b>FC1Dis.</b> Read-write. Reset: 0. 0=FC1 flow control loop enabled. 1=FC1 flow control loop disabled.                                                                                                                      |
| 1     | <b>PTCAddrTransReqUpdate.</b> Read-write. Reset: 1. 0=PTEs from address translation requests are not cached. 1=PTEs from address translation requests are cached in the L2 according to the Cache bit in the DTE.            |
| 0     | <b>QueueArbFBPri.</b> Read-write. Reset: 1. 0=Requests in the miss queue and the feedback queue are arbitrated in a round-robin manner. 1=Requests in the feedback queue are given priority over requests in the miss queue. |

**D0F2xF4\_x4D L2\_CONTROL\_6**

| Bits  | Description                                                                                                                                                                                                                                                                       |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:24 | <b>Perf2Threshold</b> . Read-write. Reset: 0. Fifo threshold level used to calculate certain performance counter values.                                                                                                                                                          |
| 23:17 | Reserved.                                                                                                                                                                                                                                                                         |
| 16    | <b>SeqInvBurstLimitEn</b> . Read-write. Reset: 1. Enable stalling PDC requests to allow invalidation cycles to make forward progress based upon SeqInvBurstLimitInv and SeqInvBurstLimitPDCReq.                                                                                   |
| 15:8  | <b>SeqInvBurstLimitPDCReq</b> . Read-write. Reset: 8h. Sets the number of consecutive IOMMU PDC requests to perform when doing sequential invalidation. PDC and invalidation requests will alternate access to the PDC based upon SeqInvBurstLimitInv and SeqInvBurstLimitPDCReq. |
| 7:0   | <b>SeqInvBurstLimitInv</b> . Read-write. Reset: 8h. Sets the number of consecutive invalidation requests to perform when doing sequential invalidation. PDC and invalidation requests will alternate access to the PDC based upon SeqInvBurstLimitInv and SeqInvBurstLimitPDCReq. |

**D0F2xF4\_x50 L2\_PDC\_CONTROL**

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                               |      |             |     |                            |     |                              |     |                                  |     |                                         |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|-----|----------------------------|-----|------------------------------|-----|----------------------------------|-----|-----------------------------------------|
| 31:28 | <b>PDCEntries</b> . Read-only. Reset: 0. Indicates the number of entries in the PDC is indicated as $2^{\text{PDCEntries}}$                                                                                                                                                                                                                                                                                                                               |      |             |     |                            |     |                              |     |                                  |     |                                         |
| 27:24 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                 |      |             |     |                            |     |                              |     |                                  |     |                                         |
| 23:16 | <b>PDCWays</b> . Read-only. Reset: 0. Indicates the number of ways in the PDC                                                                                                                                                                                                                                                                                                                                                                             |      |             |     |                            |     |                              |     |                                  |     |                                         |
| 15    | <b>PDCParitySupport</b> . Read-only. Reset: 0. 0=The PDC does not support parity protection . 1=The PDC supports parity protection                                                                                                                                                                                                                                                                                                                        |      |             |     |                            |     |                              |     |                                  |     |                                         |
| 14    | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                 |      |             |     |                            |     |                              |     |                                  |     |                                         |
| 13    | <b>PDCBypass</b> . Read-write. Reset: 0. When set, all requests bypass the PDC. This prevents the multiple issue of requests and increases maximum rate of requests to the table-walker.                                                                                                                                                                                                                                                                  |      |             |     |                            |     |                              |     |                                  |     |                                         |
| 12    | <b>PDCSearchDirection</b> . Read-write. Reset: 0. 0=Search PDC from higher levels down . 1=Search PDC from lower levels up                                                                                                                                                                                                                                                                                                                                |      |             |     |                            |     |                              |     |                                  |     |                                         |
| 11    | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                 |      |             |     |                            |     |                              |     |                                  |     |                                         |
| 10    | <b>PDCSoftInvalidate</b> . Read-write. Reset: 0. Software may write this register to 1 to invalidate all entries in the PDC                                                                                                                                                                                                                                                                                                                               |      |             |     |                            |     |                              |     |                                  |     |                                         |
| 9:8   | <b>PDCInvalidationSel</b> . Read-write. Reset: 0. BIOS: See <a href="#">2.12.2</a> . Selects the PDC invalidation algorithm.<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>Invalidate the entire PDC.</td></tr> <tr> <td>01b</td><td>Fast imprecise invalidation.</td></tr> <tr> <td>10b</td><td>Sequential precise invalidation.</td></tr> <tr> <td>11b</td><td>Partial sequential precise invalidation</td></tr> </table> | Bits | Description | 00b | Invalidate the entire PDC. | 01b | Fast imprecise invalidation. | 10b | Sequential precise invalidation. | 11b | Partial sequential precise invalidation |
| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                               |      |             |     |                            |     |                              |     |                                  |     |                                         |
| 00b   | Invalidate the entire PDC.                                                                                                                                                                                                                                                                                                                                                                                                                                |      |             |     |                            |     |                              |     |                                  |     |                                         |
| 01b   | Fast imprecise invalidation.                                                                                                                                                                                                                                                                                                                                                                                                                              |      |             |     |                            |     |                              |     |                                  |     |                                         |
| 10b   | Sequential precise invalidation.                                                                                                                                                                                                                                                                                                                                                                                                                          |      |             |     |                            |     |                              |     |                                  |     |                                         |
| 11b   | Partial sequential precise invalidation                                                                                                                                                                                                                                                                                                                                                                                                                   |      |             |     |                            |     |                              |     |                                  |     |                                         |
| 7:5   | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                 |      |             |     |                            |     |                              |     |                                  |     |                                         |
| 4     | <b>PDCParityEn</b> . Read-write. Reset: 0. Enable parity protection of the PDC if the device supports parity                                                                                                                                                                                                                                                                                                                                              |      |             |     |                            |     |                              |     |                                  |     |                                         |

|     |                                                                                                                                                                                                                                                                 |
|-----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 3   | <b>PDCLRUpdatePri.</b> Read-write. Reset: 0. 0=Reads update replacement state bits when there is a simultaneous read and write to the same PDC index . 1=Writes update replacement state bits when there is a simultaneous read and write to the same PDC index |
| 2   | Reserved.                                                                                                                                                                                                                                                       |
| 1:0 | <b>PDCReplacementSel.</b> Read-write. Reset: 1. Selects the PDC replacement algorithm. Implementation may not support all replacement algorithms                                                                                                                |

#### D0F2xF4\_x51 L2\_PDC\_HASH\_CONTROL

| Bits  | Description                                                                                                                                                                                                                   |
|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:16 | <b>PDCAddressMask.</b> Read-write. Reset: 0h. This register is a bit-wise AND mask that selects which virtual address bits are used to index into the PDC.                                                                    |
| 15:11 | Reserved.                                                                                                                                                                                                                     |
| 10    | <b>PdcAltHashEn.</b> Read-write. Reset: 0. 1=Enable alternative algorithm for generating hash index into the PDC.                                                                                                             |
| 9     | <b>PDCUpperLvlAddrHash.</b> Read-write. Reset: 1. When set to 1, the PDC cache index is partially formed using the xor of the LSBs of virtual address bits for all levels greater than or equal to the stored/searched level. |
| 8     | <b>PDCLvlHash.</b> Read-write. Reset: 1. When set to 1, the PDE level is used as part of the hash for the cache index.                                                                                                        |
| 7:6   | Reserved.                                                                                                                                                                                                                     |
| 5:0   | <b>PDCDomainBits.</b> Read-write. Reset: 7h. Selects the number of domain bits to use as part of the index into the PDC                                                                                                       |

#### D0F2xF4\_x52 L2\_PDC\_WAY\_CONTROL

| Bits  | Description                                                                                                                                                                                                                                       |
|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:16 | <b>PDCWayAccessDisable.</b> Read-write. Reset: 0.                                                                                                                                                                                                 |
| 15:0  | <b>PDCWayDisable.</b> Read-write. Reset: 0. Each bit in this register disables a way in the PDC when set to 1. An implementation may have less than 32 ways. The entire cache may be disabled by setting the PDCWays lower bits of this register. |

#### D0F2xF4\_x53 L2B\_UPDATE\_FILTER\_CNTL

| Bits | Description                                                                                                                                                                                   |
|------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:5 | Reserved.                                                                                                                                                                                     |
| 4:1  | <b>L2bUpdateFilterRdlatency.</b> Read-write. Reset: 3h. When L2b_Update_Filter_Bypass is 0, assume the invalidation read has completed in the number of clock cycles specified by this field. |
| 0    | <b>L2bUpdateFilterBypass.</b> Read-write. Reset: 1. 1 - Disable duplicate update filtering;. 0 - Enable the dropping of updates that are already in the l2b_update_filter or in the PDC.      |

**D0F2xF4\_x54 L2\_TW\_CONTROL**

| Bits  | Description                                                                                                                                                                                                              |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:19 | Reserved.                                                                                                                                                                                                                |
| 18    | <b>TwContWalkPErrDis.</b> Read-write. Reset: 0. 0=Continue walking tables on a write permission error. 1=Stop walking tables on a write permission error                                                                 |
| 17    | <b>Twfilter64bDis.</b> Read-write. Reset: 0.                                                                                                                                                                             |
| 16    | <b>TwfilterDis.</b> Read-write. Reset: 0.                                                                                                                                                                                |
| 15    | Reserved.                                                                                                                                                                                                                |
| 14:12 | <b>TWPrefetchRange.</b> Read-write. Reset: 1. Selects the number of pages to prefetch                                                                                                                                    |
| 11    | <b>TWPTEOnAddrTransExcl.</b> Read-write. Reset: 0. 0=Table walker returns DTE to L1 on an address translation exclusion range access . 1=Table walker returns PTE to L1 on an address translation exclusion range access |
| 10    | <b>TWPTEOnUntransExcl.</b> Read-write. Reset: 0. 0=Table walker returns DTE to L1 on an untranslated exclusion range access . 1=Table walker returns PTE to L1 on an untranslated exclusion range access                 |
| 9     | <b>TWPrefetchOnly4KDis.</b> Read-write. Reset: 0. 1=Allow non-4K pages to be prefetched . 0=Only 4K pages are prefetched                                                                                                 |
| 8     | <b>TWPrefetchEn.</b> Read-write. Reset: 0. Enable prefetching in the table-walker                                                                                                                                        |
| 7     | Reserved.                                                                                                                                                                                                                |
| 6     | <b>TWForceCoherent.</b> Read-write. Reset: 0. 1=Table-walker always generates coherent requests. The DTE SD bit is ignored when this bit is set to 1.                                                                    |
| 5:0   | <b>TWQueueLimit.</b> Read-write. Reset: 10h. Limit the number of outstanding table-walker requests                                                                                                                       |

**D0F2xF4\_x56 L2\_CP\_CONTROL**

| Bits  | Description                                                                                                                                                                                   |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:16 | <b>CPRdDelay.</b> Read-write. Reset: 0. Command processor read delay                                                                                                                          |
| 15:3  | Reserved.                                                                                                                                                                                     |
| 2     | <b>CPFlushOnInv.</b> Read-write. Reset: 1. BIOS: 0. 1=Command processor flushes out old requests on every invalidation command . 0=No flush is performed during invalidations                 |
| 1     | <b>CPFlushOnWait.</b> Read-write. Reset: 0. BIOS: 1. 1=Command processor flushes out old requests on completion wait . 0=No flush is performed on completion wait                             |
| 0     | <b>CPPrefetchDis.</b> Read-write. Reset: 0. 1=Command processor fetches and executes only one command at a time . 0=Command processor prefetches available commands into its internal storage |

**D0F2xF4\_x57 L2\_CP\_CONTROL\_1**

| Bits  | Description |
|-------|-------------|
| 31:16 | Reserved.   |



|      |                                                                                                                                                                                                                                                                |
|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 15:3 | <b>CPL1Off[15:3]</b> . Read-write. Reset: 0. Each bit in this register indicates to the IOMMU command processor that a corresponding L1 TLB is inaccessible due to static clock or power gating. System software is responsible for programming this register. |
| 2    | <b>L1ImuIntGfxDis</b> . Read-write. Reset: 0. BIOS: IF ( <b>GpuEnabled</b> ) THEN 0 ELSE 1 ENDIF.                                                                                                                                                              |
| 1    | <b>CPL1Off[1]</b> . Read-write. Reset: 0.                                                                                                                                                                                                                      |
| 0    | <b>L1ImuPcieGfxDis</b> . Read-write. Reset: 0. BIOS: This bit should be set if there is no external graphics in the system.                                                                                                                                    |

#### **D0F2xF4\_x58 IOMMU\_L2\_GUEST\_ADDR\_CNTRL**

| Bits  | Description                                         |
|-------|-----------------------------------------------------|
| 31:24 | Reserved.                                           |
| 23:0  | <b>IommuL2GuestAddrMask</b> . Read-write. Reset: 0. |

#### **D0F2xF4\_x60 L2\_TW\_CONTROL\_1**

| Bits  | Description                                                                                                                                                                 |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:15 | <b>TWDebugMask</b> . Read-write. Reset: 0. Defines the table-walker trace buffer size by masking address bits 31:16.                                                        |
| 14:3  | Reserved.                                                                                                                                                                   |
| 2     | <b>TWDebugForceDisable</b> . Read-write. Reset: 0. When set to 1, this register disables the TW Debug feature until a cold-reset is performed.                              |
| 1     | <b>TWDebugNoWrap</b> . Read-write. Reset: 0. 1=Table-walker trace to stop at the top of the trace buffer. 0=Table-walker trace wraps around at the top of the trace buffer. |
| 0     | <b>TWDebugEn</b> . Read-write. Reset: 0. Enables table-walker trace debug mode.                                                                                             |

#### **D0F2xF4\_x61 L2\_TW\_CONTROL\_2**

| Bits  | Description                                                                                       |
|-------|---------------------------------------------------------------------------------------------------|
| 31:12 | <b>TWDebugAddrLo</b> . Read-write. Reset: 0. Base address bits 31:12 for table-walker trace debug |
| 11:0  | Reserved.                                                                                         |

#### **D0F2xF4\_x62 L2\_TW\_CONTROL\_3**

| Bits | Description                                                                                       |
|------|---------------------------------------------------------------------------------------------------|
| 31:0 | <b>TWDebugAddrHi</b> . Read-write. Reset: 0. Base address bits 51:32 for table-walker trace debug |

#### **D0F2xF4\_x6A L2\_INT\_CONTROL**

| Bits | Description |
|------|-------------|
| 31:3 | Reserved.   |

|   |                                                                                                            |
|---|------------------------------------------------------------------------------------------------------------|
| 2 | <b>IntPPROrderEn.</b> Read-write. Reset: 1. Enable ordering between interrupts and ppr log writes          |
| 1 | <b>IntCPOrderEn.</b> Read-write. Reset: 1. Enable ordering between interrupts and command processor writes |
| 0 | <b>IntEventOrderEn.</b> Read-write. Reset: 1. Enable ordering between interrupts and event log writes      |

**D0F2xF4\_x70 L2\_CREDIT\_CONTROL\_0**

| Bits  | Description                                                                                                                                                                         |
|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31    | <b>DTEOverride.</b> Read-write. Reset: 0. Changing this register from 0 to 1 overrides the DTE credit counter with DTECredits. This should only be performed when the IOMMU is idle |
| 30    | Reserved.                                                                                                                                                                           |
| 29:24 | <b>DTECredits.</b> Read-write. Reset: 2h. DTE credit override value                                                                                                                 |
| 23    | <b>FC3Override.</b> Read-write. Reset: 0. Changing this register from 0 to 1 overrides the FC3 credit counter with FC3Credits. This should only be performed when the IOMMU is idle |
| 22    | Reserved.                                                                                                                                                                           |
| 21:16 | <b>FC3Credits.</b> Read-write. Reset: 0. FC3 credit override value                                                                                                                  |
| 15    | <b>FC2Override.</b> Read-write. Reset: 0. Changing this register from 0 to 1 overrides the FC2 credit counter with FC2Credits. This should only be performed when the IOMMU is idle |
| 14    | Reserved.                                                                                                                                                                           |
| 13:8  | <b>FC2Credits.</b> Read-write. Reset: 0. FC2 credit override value                                                                                                                  |
| 7     | <b>FC1Override.</b> Read-write. Reset: 0. Changing this register from 0 to 1 overrides the FC1 credit counter with FC1Credits. This should only be performed when the IOMMU is idle |
| 6     | Reserved.                                                                                                                                                                           |
| 5:0   | <b>FC1Credits.</b> Read-write. Reset: 0. FC1 credit override value                                                                                                                  |

**D0F2xF4\_x71 L2\_CREDIT\_CONTROL\_1**

| Bits  | Description                                                                                                                                                                              |
|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:24 | Reserved.                                                                                                                                                                                |
| 23:20 | <b>PprMcifCredits.</b> Read-write. Reset: 4h. PPR logger credit override value                                                                                                           |
| 19:16 | <b>CpPrefetchCredits.</b> Read-write. Reset: 4h. Command processor prefetch credit override value                                                                                        |
| 15    | <b>TWELOverride.</b> Read-write. Reset: 0. Changing this register from 0 to 1 overrides the TWEL credit counter with TWELCredits. This should only be performed when the IOMMU is idle   |
| 14    | Reserved.                                                                                                                                                                                |
| 13:8  | <b>TWELCredits.</b> Read-write. Reset: 4h. TWEL credit override value                                                                                                                    |
| 7     | <b>PDTIEOverride.</b> Read-write. Reset: 0. Changing this register from 0 to 1 overrides the PDTIEcredit counter with PDTIECredits. This should only be performed when the IOMMU is idle |
| 6     | Reserved.                                                                                                                                                                                |
| 5:0   | <b>PDTIECredits.</b> Read-write. Reset: 4h. PDTIE credit override value                                                                                                                  |

**D0F2xF4\_x78 L2\_MCIF\_CONTROL**

| Bits  | Description                                                                                                                                                                                                                         |
|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:29 | Reserved.                                                                                                                                                                                                                           |
| 28:24 | <b>MCIFBaseWriteDataCredits</b> . Read-write. Reset: 8h. Sets the number of base-channel write data credits between the IOMMU L2 and the HTIU/ORB. SW must ensure no traffic is on this data path while programming this register.  |
| 23:21 | Reserved.                                                                                                                                                                                                                           |
| 20:16 | <b>MCIFBaseWriteHdrCredits</b> . Read-write. Reset: 8h. Sets the number of base-channel write header credits between the IOMMU L2 and the HTIU/ORB. SW must ensure no traffic is on this data path while programming this register. |
| 15:13 | Reserved.                                                                                                                                                                                                                           |
| 12:8  | <b>MCIFIsocReadCredits</b> . Read-write. Reset: 8h. Sets the number of isoc-channel read credits between the IOMMU L2 and the HTIU/ORB. SW must ensure no traffic is on this data path while programming this register.             |
| 7:5   | Reserved.                                                                                                                                                                                                                           |
| 4:0   | <b>MCIFBaseReadCredits</b> . Read-write. Reset: 8h. Sets the number of base-channel read credits between the IOMMU L2 and the HTIU/ORB. SW must ensure no traffic is on this data path while programming this register.             |

**D0F2xF4\_x80 L2\_ERR\_RULE\_CONTROL\_0**

| Bits | Description                                                                                                                                                                     |
|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:4 | <b>ERRRuleDisable0</b> . Read-write. Reset: 0. Each bit in this register disables an error detection rule in the IOMMU.                                                         |
| 3:1  | Reserved.                                                                                                                                                                       |
| 0    | <b>ERRRuleLock0</b> . Read-write. Reset: 0. BIOS: See 2.12.2. This register is write-once. Setting this register bit locks the error detection rule set in ERRRuleDisable0/1/2. |

**D0F2xF4\_x81 L2\_ERR\_RULE\_CONTROL\_1**

| Bits | Description                                                                                                             |
|------|-------------------------------------------------------------------------------------------------------------------------|
| 31:0 | <b>ERRRuleDisable1</b> . Read-write. Reset: 0. Each bit in this register disables an error detection rule in the IOMMU. |

**D0F2xF4\_x82 L2\_ERR\_RULE\_CONTROL\_2**

| Bits | Description                                                                                                             |
|------|-------------------------------------------------------------------------------------------------------------------------|
| 31:0 | <b>ERRRuleDisable2</b> . Read-write. Reset: 0. Each bit in this register disables an error detection rule in the IOMMU. |

**D0F2xF4\_x90 L2\_L2B\_CK\_GATE\_CONTROL**

| Bits | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |      |             |     |                                                                                |     |                                                                                |     |                                                                                |     |                                                                                 |
|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|-----|--------------------------------------------------------------------------------|-----|--------------------------------------------------------------------------------|-----|--------------------------------------------------------------------------------|-----|---------------------------------------------------------------------------------|
| 31:8 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |      |             |     |                                                                                |     |                                                                                |     |                                                                                |     |                                                                                 |
| 7:6  | <b>CKGateL2BStop</b> . Read-write. Reset: 01b.<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>Allow 2 clock cycles delay before stopping the clocks when clkready deasserts.</td></tr> <tr> <td>01b</td><td>Allow 4 clock cycles delay before stopping the clocks when clkready deasserts.</td></tr> <tr> <td>10b</td><td>Allow 8 clock cycles delay before stopping the clocks when clkready deasserts.</td></tr> <tr> <td>11b</td><td>Allow 16 clock cycles delay before stopping the clocks when clkready deasserts.</td></tr> </table> | Bits | Description | 00b | Allow 2 clock cycles delay before stopping the clocks when clkready deasserts. | 01b | Allow 4 clock cycles delay before stopping the clocks when clkready deasserts. | 10b | Allow 8 clock cycles delay before stopping the clocks when clkready deasserts. | 11b | Allow 16 clock cycles delay before stopping the clocks when clkready deasserts. |
| Bits | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |      |             |     |                                                                                |     |                                                                                |     |                                                                                |     |                                                                                 |
| 00b  | Allow 2 clock cycles delay before stopping the clocks when clkready deasserts.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |      |             |     |                                                                                |     |                                                                                |     |                                                                                |     |                                                                                 |
| 01b  | Allow 4 clock cycles delay before stopping the clocks when clkready deasserts.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |      |             |     |                                                                                |     |                                                                                |     |                                                                                |     |                                                                                 |
| 10b  | Allow 8 clock cycles delay before stopping the clocks when clkready deasserts.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |      |             |     |                                                                                |     |                                                                                |     |                                                                                |     |                                                                                 |
| 11b  | Allow 16 clock cycles delay before stopping the clocks when clkready deasserts.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |      |             |     |                                                                                |     |                                                                                |     |                                                                                |     |                                                                                 |
| 5:4  | <b>CKGateL2BLength</b> . Read-write. Reset: 01b.<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>Allow 128 clock cycles delay before stopping the clocks when idle asserts.</td></tr> <tr> <td>01b</td><td>Allow 256 clock cycles delay before stopping the clocks when idle asserts.</td></tr> <tr> <td>10b</td><td>Allow 512 clock cycles delay before stopping the clocks when idle asserts.</td></tr> <tr> <td>11b</td><td>Allow 1024 clock cycles delay before stopping the clocks when idle asserts.</td></tr> </table>               | Bits | Description | 00b | Allow 128 clock cycles delay before stopping the clocks when idle asserts.     | 01b | Allow 256 clock cycles delay before stopping the clocks when idle asserts.     | 10b | Allow 512 clock cycles delay before stopping the clocks when idle asserts.     | 11b | Allow 1024 clock cycles delay before stopping the clocks when idle asserts.     |
| Bits | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |      |             |     |                                                                                |     |                                                                                |     |                                                                                |     |                                                                                 |
| 00b  | Allow 128 clock cycles delay before stopping the clocks when idle asserts.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |      |             |     |                                                                                |     |                                                                                |     |                                                                                |     |                                                                                 |
| 01b  | Allow 256 clock cycles delay before stopping the clocks when idle asserts.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |      |             |     |                                                                                |     |                                                                                |     |                                                                                |     |                                                                                 |
| 10b  | Allow 512 clock cycles delay before stopping the clocks when idle asserts.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |      |             |     |                                                                                |     |                                                                                |     |                                                                                |     |                                                                                 |
| 11b  | Allow 1024 clock cycles delay before stopping the clocks when idle asserts.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |      |             |     |                                                                                |     |                                                                                |     |                                                                                |     |                                                                                 |
| 3    | <b>CKGateL2BCacheDisable</b> . Read-write. Reset: 0. 1=Disable the gating of the l2b upper cache ways.                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |      |             |     |                                                                                |     |                                                                                |     |                                                                                |     |                                                                                 |
| 2    | <b>CKGateL2BMiscDisable</b> . Read-write. Reset: 1. 1=Disable the gating of the l2b miscellaneous clock branch.                                                                                                                                                                                                                                                                                                                                                                                                                                                         |      |             |     |                                                                                |     |                                                                                |     |                                                                                |     |                                                                                 |
| 1    | <b>CKGateL2BDynamicDisable</b> . Read-write. Reset: 1. BIOS: 0. 1=Disable the gating of the l2b dynamic clock branch.                                                                                                                                                                                                                                                                                                                                                                                                                                                   |      |             |     |                                                                                |     |                                                                                |     |                                                                                |     |                                                                                 |
| 0    | <b>CKGateL2BRegsDisable</b> . Read-write. Reset: 1. BIOS: 0. 1=Disable the gating of the l2b register clock branch.                                                                                                                                                                                                                                                                                                                                                                                                                                                     |      |             |     |                                                                                |     |                                                                                |     |                                                                                |     |                                                                                 |

**D0F2xF4\_x92 PPR\_CONTROL**

| Bits  | Description                                                                        |
|-------|------------------------------------------------------------------------------------|
| 31:17 | Reserved.                                                                          |
| 16    | <b>PprIntcoalesceEn</b> . Read-write. Reset: 0. BIOS: See <a href="#">2.12.2</a> . |
| 15:8  | <b>PprIntreqdelay</b> . Read-write. Reset: 0. BIOS: See <a href="#">2.12.2</a> .   |
| 7:0   | <b>PprInttimedelay</b> . Read-write. Reset: 0. BIOS: See <a href="#">2.12.2</a> .  |

**D0F2xF4\_x94 L2\_L2B\_PGSize\_CONTROL**

| Bits | Description                                                                        |
|------|------------------------------------------------------------------------------------|
| 31:4 | Reserved.                                                                          |
| 3:2  | <b>L2bregHostPgsize</b> . Read-write. Reset: 0. BIOS: See <a href="#">2.12.2</a> . |
| 1:0  | <b>L2bregGstPgsize</b> . Read-write. Reset: 0. BIOS: See <a href="#">2.12.2</a> .  |

**D0F2xF8 IOMMU L1 Config Index**

The index/data pair registers, [D0F2xF8](#) and [D0F2xFC](#) are used to access the registers at [D0F2xFC\\_x\[FFFF:0000\]\\_L1\[3:0\]](#). To access any of these registers, the address is first written into the index

register, [D0F2xF8](#), and then the data is read from or written to the data register, [D0F2xFC](#).

See [2.12.1 \[IOMMU Configuration Space\]](#). There are various L1s in the IOMMU. Registers in the L1 indexed space have one instance per L1 denoted by `_L1i[x]` where `x=D0F2xF8[L1cfgSel]`. The syntax for this register type is described by the following example:

- `D0F2xFC_x00` refers to all instances of the `D0F2xFC_x00` registers.
- `D0F2xFC_x00_L1i[0]` refers to the `D0F2xFC_x00` register instance for the PGD L1.

| Bits        | Description                                                                                                                                                                                                                                                                                                                                                                                           |             |                   |             |                   |    |     |    |     |    |      |    |        |    |      |       |          |
|-------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|-------------------|-------------|-------------------|----|-----|----|-----|----|------|----|--------|----|------|-------|----------|
| 31          | <b>L1cfgEn</b> . Read-write. Reset: 0. 1=Enable writes to <a href="#">D0F2xFC</a> .                                                                                                                                                                                                                                                                                                                   |             |                   |             |                   |    |     |    |     |    |      |    |        |    |      |       |          |
| 30:20       | Reserved.                                                                                                                                                                                                                                                                                                                                                                                             |             |                   |             |                   |    |     |    |     |    |      |    |        |    |      |       |          |
| 19:16       | <b>L1cfgSel</b> . Read-write. Reset: 0. This field selects one of the following L1s to access. <table><tr><th><u>Bits</u></th><th><u>Definition</u></th><th><u>Bits</u></th><th><u>Definition</u></th></tr><tr><td>0h</td><td>PGD</td><td>3h</td><td>BIF</td></tr><tr><td>1h</td><td>PSD1</td><td>4h</td><td>INTGEN</td></tr><tr><td>2h</td><td>PSD0</td><td>Fh-5h</td><td>Reserved</td></tr></table> | <u>Bits</u> | <u>Definition</u> | <u>Bits</u> | <u>Definition</u> | 0h | PGD | 3h | BIF | 1h | PSD1 | 4h | INTGEN | 2h | PSD0 | Fh-5h | Reserved |
| <u>Bits</u> | <u>Definition</u>                                                                                                                                                                                                                                                                                                                                                                                     | <u>Bits</u> | <u>Definition</u> |             |                   |    |     |    |     |    |      |    |        |    |      |       |          |
| 0h          | PGD                                                                                                                                                                                                                                                                                                                                                                                                   | 3h          | BIF               |             |                   |    |     |    |     |    |      |    |        |    |      |       |          |
| 1h          | PSD1                                                                                                                                                                                                                                                                                                                                                                                                  | 4h          | INTGEN            |             |                   |    |     |    |     |    |      |    |        |    |      |       |          |
| 2h          | PSD0                                                                                                                                                                                                                                                                                                                                                                                                  | Fh-5h       | Reserved          |             |                   |    |     |    |     |    |      |    |        |    |      |       |          |
| 15:0        | <b>L1cfgIndex</b> . Read-write. Reset: 0.                                                                                                                                                                                                                                                                                                                                                             |             |                   |             |                   |    |     |    |     |    |      |    |        |    |      |       |          |

#### D0F2xFC IOMMU L1 Config Data

IF ([D0F2xF8\[L1cfgEn\]](#)) THEN Read-write. ELSE Read-only. ENDIF. Reset: 0000\_0000h. See [D0F2xF8](#). Address: [D0F2xF8\[L1cfgIndex\]](#).

| Bits | Description        |
|------|--------------------|
| 31:0 | <b>L1cfgData</b> . |

#### D0F2xFC\_x00\_L1i[4:0] L1\_PERF\_CNTL

| Bits  | Description                                                                         |
|-------|-------------------------------------------------------------------------------------|
| 31:24 | <b>L1PerfCountHi1</b> . Read-only. Reset: 0. read back of perf counter 1 bits 39:32 |
| 23:16 | <b>L1PerfCountHi0</b> . Read-only. Reset: 0. read back of perf counter 0 bits 39:32 |
| 15:8  | <b>L1PerfEvent1</b> . Read-write. Reset: 0. perf counter event 1                    |
| 7:0   | <b>L1PerfEvent0</b> . Read-write. Reset: 0. perf counter event 0                    |

#### D0F2xFC\_x01\_L1i[4:0] L1\_PERF\_COUNT\_0

| Bits | Description                                                                      |
|------|----------------------------------------------------------------------------------|
| 31:0 | <b>L1PerfCount0</b> . Read-only. Reset: 0. read back of perf counter 0 bits 31:0 |

#### D0F2xFC\_x02\_L1i[4:0] L1\_PERF\_COUNT\_1

| Bits | Description                                                                      |
|------|----------------------------------------------------------------------------------|
| 31:0 | <b>L1PerfCount1</b> . Read-only. Reset: 0. read back of perf counter 1 bits 31:0 |

**D0F2xFC\_x07\_L1i[4:0] L1\_DEBUG\_1**

| Bits  | Description                                                                                                      |
|-------|------------------------------------------------------------------------------------------------------------------|
| 31:18 | Reserved.                                                                                                        |
| 17    | <b>L1NwEn</b> . Read-write. Reset: 0. BIOS: 1. 1=Enable NW bit on ATS requests.                                  |
| 16:15 | Reserved.                                                                                                        |
| 14    | <b>AtsPhysPageOverlapDis</b> . Read-write. Reset: 0. BIOS: 1. 1=Prevent physical page overlap for ATS responses. |
| 13    | Reserved.                                                                                                        |
| 12    | <b>AtsSeqNumEn</b> . Read-write. Reset: 0. BIOS: 1. 1=Enable logging of ATS sequence number.                     |
| 11    | <b>SpecReqFilterEn</b> . Read-write. Reset: 0. BIOS: 1. 1=Filter special requests in L1 work queue.              |
| 10:1  | Reserved.                                                                                                        |
| 0     | <b>PhantomFuncDis</b> . Read-write. Reset: 0. BIOS: See 2.12.2. 1=Disable phantom function support.              |

**D0F2xFC\_x09\_L1i[4:0] L1\_SB\_LOCATION**

| Bits   | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |     |              |     |                                                                         |     |                                                         |     |                                                         |     |                                                         |        |           |
|--------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|--------------|-----|-------------------------------------------------------------------------|-----|---------------------------------------------------------|-----|---------------------------------------------------------|-----|---------------------------------------------------------|--------|-----------|
| 31:16  | <b>SbLocatedCore</b> . Read-only. Reset: 0.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |     |              |     |                                                                         |     |                                                         |     |                                                         |     |                                                         |        |           |
| 15:0   | <b>SbLocatedPort</b> . Read-write. Reset: 0. BIOS: See 2.12.2 [IOMMU Initialization]. Specifies the port location of the FCH.<br><table> <tr> <th>Bit</th><th>PortLocation</th></tr> <tr> <td>[0]</td><td>FCH is located on port A of the corresponding PCIe core or internal FCH</td></tr> <tr> <td>[1]</td><td>FCH is located on port B of the corresponding PCIe core</td></tr> <tr> <td>[2]</td><td>FCH is located on port C of the corresponding PCIe core</td></tr> <tr> <td>[3]</td><td>FCH is located on port D of the corresponding PCIe core</td></tr> <tr> <td>[15:4]</td><td>Reserved.</td></tr> </table> | Bit | PortLocation | [0] | FCH is located on port A of the corresponding PCIe core or internal FCH | [1] | FCH is located on port B of the corresponding PCIe core | [2] | FCH is located on port C of the corresponding PCIe core | [3] | FCH is located on port D of the corresponding PCIe core | [15:4] | Reserved. |
| Bit    | PortLocation                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |     |              |     |                                                                         |     |                                                         |     |                                                         |     |                                                         |        |           |
| [0]    | FCH is located on port A of the corresponding PCIe core or internal FCH                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |     |              |     |                                                                         |     |                                                         |     |                                                         |     |                                                         |        |           |
| [1]    | FCH is located on port B of the corresponding PCIe core                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |     |              |     |                                                                         |     |                                                         |     |                                                         |     |                                                         |        |           |
| [2]    | FCH is located on port C of the corresponding PCIe core                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |     |              |     |                                                                         |     |                                                         |     |                                                         |     |                                                         |        |           |
| [3]    | FCH is located on port D of the corresponding PCIe core                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |     |              |     |                                                                         |     |                                                         |     |                                                         |     |                                                         |        |           |
| [15:4] | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |     |              |     |                                                                         |     |                                                         |     |                                                         |     |                                                         |        |           |

**D0F2xFC\_x0C\_L1i[4:0] L1\_CNTRL\_0**

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                         |      |             |    |   |    |   |    |   |    |   |    |    |       |          |
|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|----|---|----|---|----|---|----|---|----|----|-------|----------|
| 31    | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                           |      |             |    |   |    |   |    |   |    |   |    |    |       |          |
| 30:28 | <b>L1VirtOrderQueues</b> . Read-write. Reset: 0.<br>BIOS: See 2.12.2. This field controls number of virtual queues in the L1 work queue.<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>0h</td><td>1</td></tr> <tr> <td>1h</td><td>2</td></tr> <tr> <td>2h</td><td>4</td></tr> <tr> <td>3h</td><td>8</td></tr> <tr> <td>4h</td><td>16</td></tr> <tr> <td>7h-5h</td><td>Reserved</td></tr> </table> | Bits | Description | 0h | 1 | 1h | 2 | 2h | 4 | 3h | 8 | 4h | 16 | 7h-5h | Reserved |
| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                         |      |             |    |   |    |   |    |   |    |   |    |    |       |          |
| 0h    | 1                                                                                                                                                                                                                                                                                                                                                                                                                   |      |             |    |   |    |   |    |   |    |   |    |    |       |          |
| 1h    | 2                                                                                                                                                                                                                                                                                                                                                                                                                   |      |             |    |   |    |   |    |   |    |   |    |    |       |          |
| 2h    | 4                                                                                                                                                                                                                                                                                                                                                                                                                   |      |             |    |   |    |   |    |   |    |   |    |    |       |          |
| 3h    | 8                                                                                                                                                                                                                                                                                                                                                                                                                   |      |             |    |   |    |   |    |   |    |   |    |    |       |          |
| 4h    | 16                                                                                                                                                                                                                                                                                                                                                                                                                  |      |             |    |   |    |   |    |   |    |   |    |    |       |          |
| 7h-5h | Reserved                                                                                                                                                                                                                                                                                                                                                                                                            |      |             |    |   |    |   |    |   |    |   |    |    |       |          |
| 27:24 | <b>L1Entries</b> . Read-only; updated-by-hardware. Reset: 0. This field specifies the number of entries in each L1 cache as $2^L$ entries.                                                                                                                                                                                                                                                                          |      |             |    |   |    |   |    |   |    |   |    |    |       |          |
| 23:22 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                           |      |             |    |   |    |   |    |   |    |   |    |    |       |          |

|       |                                                                                                              |
|-------|--------------------------------------------------------------------------------------------------------------|
| 21:20 | <b>L1Banks</b> . Read-only; updated-by-hardware. Reset: 1. This field specifies number of caches in L1.      |
| 19:14 | Reserved.                                                                                                    |
| 13:8  | <b>L2Credits</b> . Read-write. Reset: 4h. This field controls credits for L1 to L2 interface.                |
| 7:6   | Reserved.                                                                                                    |
| 5     | <b>ReplacementSel</b> . Read-write. Reset: 0.                                                                |
| 4     | Reserved.                                                                                                    |
| 3     | <b>CacheiwOnly</b> . Read-write. Reset: 1. 1=Cache write only pages in L1.                                   |
| 2     | <b>CacheirOnly</b> . Read-write. Reset: 1. 1=Cache read only pages in L1.                                    |
| 1     | <b>FragmentDis</b> . Read-write. Reset: 0. 1=Disable variable page size support in L1 cache - only 4K pages. |
| 0     | <b>UnfilterDis</b> . Read-write. Reset: 0. 1=Disable unfiltering in L1 wq of aborted L2 requests.            |

#### D0F2xFC\_x0D\_L1i[4:0] L1\_CNTRL\_1

| Bits  | Description                                                                                                                   |
|-------|-------------------------------------------------------------------------------------------------------------------------------|
| 31    | Reserved.                                                                                                                     |
| 30    | <b>L1DebugCntrMode</b> . Read-write. Reset: 0. Mode control for debug bus                                                     |
| 29    | <b>Untrans2mFilteren</b> . Read-write. Reset: 0. Enable filtering of requests on a 2M boundry instead of 4K                   |
| 28    | <b>PretransNovaFilteren</b> . Read-write. Reset: 0. When set, VA is not used for filtering pretrans requests                  |
| 27    | <b>L1CacheSelInterleave</b> . Read-write. Reset: 0. when set causes cache updates to toggle between multiple caches           |
| 26    | <b>L1CacheSelReqid</b> . Read-write. Reset: 0. when set will allow the reqid to be used in hashing between multiple L1 caches |
| 25:23 | <b>SelectTimeoutPulse</b> . Read-write. Reset: 0.                                                                             |
| 22    | <b>L1CacheInvAllEn</b> . Read-write. Reset: 0. Enables invalidation of entire cache when invalidation command is sent         |
| 21    | <b>L1orderEn</b> . Read-write. Reset: 0. Enables strict ordering of all requests through L1                                   |
| 20    | <b>SndFilterDis</b> . Read-write. Reset: 0. Disables filtering of requests to L2                                              |
| 19    | <b>AtsNobufferInsert</b> . Read-write. Reset: 0. disables buffering of read completion data when inserting ats responses      |
| 18:14 | <b>WqEntrydis</b> . Read-write. Reset: 0. Value indicates how many cache entries in L1 to disable                             |
| 13    | <b>BlockL1Dis</b> . Read-only. Reset: 0.                                                                                      |
| 12    | <b>L1DTEDis</b> . Read-write. Reset: 0. Disables L1 caching of DTE                                                            |
| 11    | <b>L1ParityEn</b> . Read-write. Reset: 0.                                                                                     |
| 10    | <b>L1CacheParityEn</b> . Read-write. Reset: 0. Enables forced miss of L1 cache due to failed parity check                     |
| 9     | <b>CacheByPass</b> . Read-write. Reset: 0. Enables L1 cache bypass                                                            |
| 8     | <b>VOQXorMode</b> . Read-write. Reset: 0.                                                                                     |
| 7     | Reserved.                                                                                                                     |
| 6:4   | <b>VOQFuncBits</b> . Read-write. Reset: 0.                                                                                    |

|     |                                                                                                                                                              |
|-----|--------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 3   | Reserved.                                                                                                                                                    |
| 2:0 | <b>VOQPortBits</b> . Read-write. Reset: 0. When not 0x0 enables virtual queue hashing using port id, controls number of bits to use from port id for hashing |

**D0F2xFC\_x0E\_L1i[4:0] L1\_CNTRL\_2**

| Bits  | Description                                                                                                                                                               |
|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:28 | Reserved.                                                                                                                                                                 |
| 27:20 | <b>MsiHtRsvIntVector</b> . Read-write. Reset: 00h. This field defines the interrupt vector used when an MSI interrupt is received that has a reserved DM field.           |
| 19:12 | <b>MsiHtRsvIntDestination</b> . Read-write. Reset: FFh. This field defines the interrupt destination used when an MSI interrupt is received that has a reserved DM field. |
| 11    | Reserved.                                                                                                                                                                 |
| 10    | <b>MsiHtRsvIntDM</b> . Read-write. Reset: 0. Defines the interrupt destination mode when an MSI interrupt is received that has a reserved DM field.                       |
| 9     | <b>MsiHtRsvIntRqEio</b> . Read-write. Reset: 0. Specifies the RQEOI state when an MSI interrupt is received that has a reserved DM field.                                 |
| 8:6   | <b>MsiHtRsvIntMt</b> . Read-write. Reset: 011b. Specifies the message type used when an MSI interrupt is received that has a reserved DM field.                           |
| 5:3   | Reserved.                                                                                                                                                                 |
| 2     | <b>L1AbrtAtsDis</b> . Read-write. Reset: 0. 1=Disable abort of ats requests when IOMMU is disabled.                                                                       |
| 1     | <b>MsiToHtRemapDis</b> . Read-write. Reset: 0. 1=Disable mapping of MSI to link interrupts.                                                                               |
| 0     | Reserved.                                                                                                                                                                 |

**D0F2xFC\_x0F\_L1i[4:0] L1\_CNTRL\_3**

| Bits | Description                                                                                                  |
|------|--------------------------------------------------------------------------------------------------------------|
| 31:0 | <b>AtsTlbinvPulseWidth</b> . Read-write. Reset: C350h. sets the pulse width of the ats invalidation counters |

**D0F2xFC\_x10\_L1i[4:0] L1\_BANK\_SEL\_0**

| Bits  | Description                                                                                                                                                                                                                                                                    |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:16 | Reserved.                                                                                                                                                                                                                                                                      |
| 15:0  | <b>L1cachebanksel0</b> . Read-write. Reset: 1. value is used to determine the virtual address bit that selects between the 2 banks of the L1 cache (if present). The bank is selected by bitwise ANDing this register against virtual address bits 19:12 and XORing the result |

**D0F2xFC\_x11\_L1i[4:0] L1\_BANK\_DISABLE\_0**

| Bits  | Description |
|-------|-------------|
| 31:14 | Reserved.   |



|      |                                                                                                       |
|------|-------------------------------------------------------------------------------------------------------|
| 13:8 | <b>L1cachelinedis1</b> . Read-write. Reset: 0. sets the number of cache entries to disable in cache 1 |
| 7:6  | Reserved.                                                                                             |
| 5:0  | <b>L1cachelinedis0</b> . Read-write. Reset: 0. sets the number of cache entries to disable in cache 0 |

#### **D0F2xFC\_x20\_L1i[4:0] L1\_WQ\_STATUS\_0**

**Table 109: Valid Values for D0F2xFC\_x20\_L1i[4:0]**

| Bits | Description                                |
|------|--------------------------------------------|
| 0h   | Idle.                                      |
| 1h   | Wait_L1.                                   |
| 2h   | Wait_L2.                                   |
| 3h   | Sending special request to L2.             |
| 4h   | Waiting for completion of special request. |
| 5h   | Done.                                      |

| Bits  | Description                                                                                                         |
|-------|---------------------------------------------------------------------------------------------------------------------|
| 31:30 | Reserved.                                                                                                           |
| 29:27 | <b>EntryStatus9</b> . See: EntryStatus0.                                                                            |
| 26:24 | <b>EntryStatus8</b> . See: EntryStatus0.                                                                            |
| 23:21 | <b>EntryStatus7</b> . See: EntryStatus0.                                                                            |
| 20:18 | <b>EntryStatus6</b> . See: EntryStatus0.                                                                            |
| 17:15 | <b>EntryStatus5</b> . See: EntryStatus0.                                                                            |
| 14:12 | <b>EntryStatus4</b> . See: EntryStatus0.                                                                            |
| 11:9  | <b>EntryStatus3</b> . See: EntryStatus0.                                                                            |
| 8:6   | <b>EntryStatus2</b> . See: EntryStatus0.                                                                            |
| 5:3   | <b>EntryStatus1</b> . See: EntryStatus0.                                                                            |
| 2:0   | <b>EntryStatus0</b> . Read-only. Reset: 0. See: <a href="#">Table 109 [Valid Values for D0F2xFC_x20_L1i[4:0]]</a> . |

#### **D0F2xFC\_x21\_L1i[4:0] L1\_WQ\_STATUS\_1**

| Bits  | Description                                |
|-------|--------------------------------------------|
| 31:30 | Reserved.                                  |
| 29:27 | <b>EntryStatus19</b> . See: EntryStatus10. |
| 26:24 | <b>EntryStatus18</b> . See: EntryStatus10. |
| 23:21 | <b>EntryStatus17</b> . See: EntryStatus10. |
| 20:18 | <b>EntryStatus16</b> . See: EntryStatus10. |
| 17:15 | <b>EntryStatus15</b> . See: EntryStatus10. |
| 14:12 | <b>EntryStatus14</b> . See: EntryStatus10. |
| 11:9  | <b>EntryStatus13</b> . See: EntryStatus10. |

|     |                                                                                                                      |
|-----|----------------------------------------------------------------------------------------------------------------------|
| 8:6 | <b>EntryStatus12</b> . See: EntryStatus10.                                                                           |
| 5:3 | <b>EntryStatus11</b> . See: EntryStatus10.                                                                           |
| 2:0 | <b>EntryStatus10</b> . Read-only. Reset: 0. See: <a href="#">Table 109 [Valid Values for D0F2xFC_x20_L1i[4:0]]</a> . |

#### D0F2xFC\_x22\_L1i[4:0] L1\_WQ\_STATUS\_2

| Bits  | Description                                                                                                          |
|-------|----------------------------------------------------------------------------------------------------------------------|
| 31:30 | Reserved.                                                                                                            |
| 29:27 | <b>EntryStatus29</b> . See: EntryStatus20.                                                                           |
| 26:24 | <b>EntryStatus28</b> . See: EntryStatus20.                                                                           |
| 23:21 | <b>EntryStatus27</b> . See: EntryStatus20.                                                                           |
| 20:18 | <b>EntryStatus26</b> . See: EntryStatus20.                                                                           |
| 17:15 | <b>EntryStatus25</b> . See: EntryStatus20.                                                                           |
| 14:12 | <b>EntryStatus24</b> . See: EntryStatus20.                                                                           |
| 11:9  | <b>EntryStatus23</b> . See: EntryStatus20.                                                                           |
| 8:6   | <b>EntryStatus22</b> . See: EntryStatus20.                                                                           |
| 5:3   | <b>EntryStatus21</b> . See: EntryStatus20.                                                                           |
| 2:0   | <b>EntryStatus20</b> . Read-only. Reset: 0. See: <a href="#">Table 109 [Valid Values for D0F2xFC_x20_L1i[4:0]]</a> . |

#### D0F2xFC\_x23\_L1i[4:0] L1\_WQ\_STATUS\_3

| Bits  | Description                                                                                                          |
|-------|----------------------------------------------------------------------------------------------------------------------|
| 31:16 | Reserved.                                                                                                            |
| 15:8  | <b>InvalidationStatus</b> . Read-only. Reset: 0. status of invalidation state machine                                |
| 7:6   | Reserved.                                                                                                            |
| 5:3   | <b>EntryStatus31</b> . See: EntryStatus30.                                                                           |
| 2:0   | <b>EntryStatus30</b> . Read-only. Reset: 0. See: <a href="#">Table 109 [Valid Values for D0F2xFC_x20_L1i[4:0]]</a> . |

#### D0F2xFC\_x32\_L1i[4:0] L1\_CNTRL\_4

| Bits  | Description                                      |
|-------|--------------------------------------------------|
| 31:20 | Reserved.                                        |
| 19:17 | <b>ForceDmaAttrLow</b> . Read-write. Reset: 0.   |
| 16    | <b>DmaNpHaltDis</b> . Read-write. Reset: 0.      |
| 15:10 | <b>DmaBufMaxNpCred</b> . Read-write. Reset: Fh.  |
| 9:4   | <b>DmaBufCredits</b> . Read-write. Reset: 10h.   |
| 3     | <b>TlpprefixerrEn</b> . Read-write. Reset: 0.    |
| 2     | <b>TimeoutPulseExtEn</b> . Read-write. Reset: 0. |

|   |                                                                                      |
|---|--------------------------------------------------------------------------------------|
| 1 | <b>AtsMultipleL1toL2En.</b> Read-write. Reset: 0. BIOS: See <a href="#">2.12.2</a> . |
| 0 | <b>AtsMultipleRespEn.</b> Read-write. Reset: 0. BIOS: See <a href="#">2.12.2</a> .   |

**D0F2xFC\_x33\_L1i[4:0] L1\_CLKCNTRL\_0**

| Bits  | Description                                                |
|-------|------------------------------------------------------------|
| 31    | <b>L1L2ClkgateEn.</b> Read-write. Reset: 0. BIOS: 1.       |
| 30:12 | Reserved.                                                  |
| 11    | <b>L1HostreqClkgateEn.</b> Read-write. Reset: 0. BIOS: 1.  |
| 10    | <b>L1RegClkgateEn.</b> Read-write. Reset: 0. BIOS: 1.      |
| 9     | <b>L1MemoryClkgateEn.</b> Read-write. Reset: 0. BIOS: 1.   |
| 8     | <b>L1PerfClkgateEn.</b> Read-write. Reset: 0. BIOS: 1.     |
| 7     | <b>L1DmaInputClkgateEn.</b> Read-write. Reset: 0. BIOS: 1. |
| 6     | <b>L1CpslvClkgateEn.</b> Read-write. Reset: 0. BIOS: 1.    |
| 5     | <b>L1CacheClkgateEn.</b> Read-write. Reset: 0. BIOS: 1.    |
| 4     | <b>L1DmaClkgateEn.</b> Read-write. Reset: 0. BIOS: 1.      |
| 3:2   | Reserved.                                                  |
| 1:0   | <b>L1ClkgateLen.</b> Read-write. Reset: 0.                 |

**D0F2xFC\_x34\_L1i[4:0] L1\_MEMPWRCNTRL\_0**

| Bits  | Description                                   |
|-------|-----------------------------------------------|
| 31:24 | <b>L1MempwrTimer2.</b> Read-write. Reset: Fh. |
| 23:16 | <b>L1MempwrTimer1.</b> Read-write. Reset: Fh. |
| 15:8  | <b>L1MempwrTimer0.</b> Read-write. Reset: Fh. |
| 7:1   | Reserved.                                     |
| 0     | <b>L1MempwrEn.</b> Read-write. Reset: 0.      |

**D0F2xFC\_x35\_L1i[4:0] L1\_MEMPWRCNTRL\_1**

| Bits | Description                                   |
|------|-----------------------------------------------|
| 31:8 | Reserved.                                     |
| 7:0  | <b>L1MempwrTimer3.</b> Read-write. Reset: Fh. |

**D0F2xFC\_x36\_L1i[4:0] L1\_GUEST\_ADDR\_CNTRL**

| Bits | Description                                  |
|------|----------------------------------------------|
| 31:8 | <b>L1GuestAddrMsk.</b> Read-write. Reset: 0. |

|     |                                                 |
|-----|-------------------------------------------------|
| 7:1 | Reserved.                                       |
| 0   | <b>L1CanonicalErrEn</b> . Read-write. Reset: 0. |

**D0F2xFC\_x37\_L1i[4:0] L1\_FEATURE\_SUP\_CNTRL**


---

| Bits | Description                             |
|------|-----------------------------------------|
| 31:2 | Reserved.                               |
| 1    | <b>L1PprSup</b> . Read-write. Reset: 1. |
| 0    | <b>L1EfrSup</b> . Read-write. Reset: 1. |

**D0F2xFC\_x38\_L1i[4:0] L1\_CNTRL\_5**


---

| Bits  | Description                                                                                                                                    |
|-------|------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:14 | Reserved.                                                                                                                                      |
| 13:8  | <b>ClkOffWaitTime</b> . Read-write. Reset: 00_0011b. Programmable delay between clkready de-assert and lclk_idle assert (ie. turning off clk). |
| 7:6   | Reserved.                                                                                                                                      |
| 5:4   | <b>HstCredits</b> . Read-write. Reset: 10b. Number of credits available for host response credit/debit interface.                              |
| 3:0   | <b>DmaCredits</b> . Read-write. Reset: 8h. Number of credits available for dma request credit/debit interface.                                 |

### 3.5 Device 1 Function 0 (Internal Graphics) Configuration Registers

See 3.1 [Register Descriptions and Mnemonics]. See 2.7 [Configuration Space].

#### D1F0x00 Device/Vendor ID

| Bits  | Description                                                          |
|-------|----------------------------------------------------------------------|
| 31:16 | <b>DeviceID: device ID.</b><br>Read-only. Value: Product-specific. . |
| 15:0  | <b>VendorID: vendor ID.</b> Read-only.<br>Value: 1002h.              |

#### D1F0x04 Status/Command Register

Reset: 0010\_0000h.

| Bits  | Description                                                                                                                                                                      |
|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31    | <b>ParityErrorDetected: detected parity error.</b> Read; Write-1-to-clear. 1=Poisoned TLP received.                                                                              |
| 30    | <b>SignaledSystemError: signaled system error.</b> Read; Write-1-to-clear. 1=A non-fatal or fatal error message was sent and SerrEn=1.                                           |
| 29    | <b>ReceivedMasterAbort: received master abort.</b> Read; Write-1-to-clear. 1=A completion with an unsupported request completion status was received.                            |
| 28    | <b>ReceivedTargetAbort: received target abort.</b> Read; Write-1-to-clear. 1=A completion with completer abort completion status was received.                                   |
| 27    | <b>SignalTargetAbort: Signaled target abort.</b> Read-only.                                                                                                                      |
| 26:25 | <b>DevselTiming: DEVSEL# Timing.</b> Read-only.                                                                                                                                  |
| 24    | <b>MasterDataPerr: master data parity error.</b> Read; Write-1-to-clear. 1=ParityErrorEn=1 and either a poisoned completion was received or the device poisoned a write request. |
| 23    | <b>FastBackCapable: fast back-to-back capable.</b> Read-only.                                                                                                                    |
| 22    | <b>UDFEn: UDF enable.</b> Read-only.                                                                                                                                             |
| 21    | <b>PCI66En: 66 MHz capable.</b> Read-only.                                                                                                                                       |
| 20    | <b>CapList: capability list.</b> Read-only. 1=Capability list supported.                                                                                                         |
| 19    | <b>IntStatus: interrupt status.</b> Read-only. 1=INTx interrupt message pending.                                                                                                 |
| 18:11 | Reserved.                                                                                                                                                                        |
| 10    | <b>IntDis: interrupt disable.</b> Read-write. 1=INTx interrupt messages generation disabled.                                                                                     |
| 9     | <b>FastB2BEn: fast back-to-back enable.</b> Read-only.                                                                                                                           |
| 8     | <b>SerrEn: System error enable.</b> Read-write. 1=Enables reporting of non-fatal and fatal errors detected.                                                                      |
| 7     | <b>Stepping: Stepping control.</b> Read-only.                                                                                                                                    |
| 6     | <b>ParityErrorEn: parity error response enable.</b> Read-write.                                                                                                                  |
| 5     | <b>PalSnoopEn: VGA palette snoop enable.</b> Read-only.                                                                                                                          |
| 4     | <b>MemWriteInvalidateEn: memory write and invalidate enable.</b> Read-only.                                                                                                      |

|   |                                                                                                                                                   |
|---|---------------------------------------------------------------------------------------------------------------------------------------------------|
| 3 | <b>SpecialCycleEn: special cycle enable.</b> Read-only.                                                                                           |
| 2 | <b>BusMasterEn: bus master enable.</b> Read-write. 1=Memory and IO read and write request generation enabled.                                     |
| 1 | <b>MemAccessEn: IO access enable.</b> Read-write. This bit controls if memory accesses targeting this device are accepted. 1=Enabled. 0=Disabled. |
| 0 | <b>IoAccessEn: IO access enable.</b> Read-write. This bit controls if IO accesses targeting this device are accepted. 1=Enabled. 0=Disabled.      |

### D1F0x08 Class Code/Revision ID Register

| Bits | Description                                         |
|------|-----------------------------------------------------|
| 31:8 | <b>ClassCode.</b> Value: 03_0000h.                  |
| 7:0  | <b>RevID: revision ID.</b> Value: Product-specific. |

### D1F0x0C Header Type Register

Reset: 0080\_0000h.

| Bits  | Description                                                                                                                |
|-------|----------------------------------------------------------------------------------------------------------------------------|
| 31:24 | <b>BIST.</b> Read-only.                                                                                                    |
| 23:16 | <b>HeaderTypeReg.</b> Read-only. The header type field indicates a header type 0 and that this is a multi-function device. |
| 15:8  | <b>LatencyTimer.</b> Read-only. These bits are fixed at their default value.                                               |
| 7:0   | <b>CacheLineSize.</b> Read-write. This field specifies the system cache line size in units of double words.                |

### D1F0x10 Graphic Memory Base Address

IF (D0F0xD4\_x0109\_14E2[StrapBifF064BarDisA]==1) THEN Reset: 0000\_0008h. ELSE Reset: 0000\_000Ch. ENDIF.

| Bits  | Description                                                                                                                                                                                                                                                                             |      |             |     |            |     |          |     |            |     |          |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|-----|------------|-----|----------|-----|------------|-----|----------|
| 31:26 | <b>BaseAddr[31:26]: base address.</b> Read-write. The amount of memory requested by the graphics memory BAR is controlled by D0F0xD4_x0109_1507[StrapBifMemApSizePin] and D0F0xD4_x0109_14E1[StrapBifMemApSize].                                                                        |      |             |     |            |     |          |     |            |     |          |
| 25:4  | <b>BaseAddr[25:4]: base address.</b> Read-only.                                                                                                                                                                                                                                         |      |             |     |            |     |          |     |            |     |          |
| 3     | <b>Pref: prefetchable.</b> Read-only. 1=Prefetchable memory region.                                                                                                                                                                                                                     |      |             |     |            |     |          |     |            |     |          |
| 2:1   | <b>Type: base address register type.</b> Read-only.<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>32-bit BAR</td></tr> <tr> <td>01b</td><td>Reserved</td></tr> <tr> <td>10b</td><td>64-bit BAR</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table> | Bits | Description | 00b | 32-bit BAR | 01b | Reserved | 10b | 64-bit BAR | 11b | Reserved |
| Bits  | Description                                                                                                                                                                                                                                                                             |      |             |     |            |     |          |     |            |     |          |
| 00b   | 32-bit BAR                                                                                                                                                                                                                                                                              |      |             |     |            |     |          |     |            |     |          |
| 01b   | Reserved                                                                                                                                                                                                                                                                                |      |             |     |            |     |          |     |            |     |          |
| 10b   | 64-bit BAR                                                                                                                                                                                                                                                                              |      |             |     |            |     |          |     |            |     |          |
| 11b   | Reserved                                                                                                                                                                                                                                                                                |      |             |     |            |     |          |     |            |     |          |
| 0     | <b>MemSpace: memory space type.</b> Read-only. 0=Memory mapped base address.                                                                                                                                                                                                            |      |             |     |            |     |          |     |            |     |          |

**D1F0x14 Graphics Memory Base Address 64**

Reset: 0000\_0000h.

| Bits | Description                                                                                                               |
|------|---------------------------------------------------------------------------------------------------------------------------|
| 31:0 | <b>BaseAddr[63:32]: base address.</b> Read-write. This field is reserved if (D0F0xD4_x0109_14E2[StrapBifF064BarDisA]==1). |

**D1F0x18 Graphics Doorbell Base Address**

IF (D0F0xD4\_x0109\_14E2[StrapBifF064BarDisA]==1) THEN Reset: 0000\_0008h. ELSE Reset: 0000\_000Ch. ENDIF. This register is reserved and reset is 0000\_0000h if (D0F0xD4\_x0109\_14E1[StrapBifDoorbellBarDis]==1).

| Bits  | Description                                                                                                                                                                                                                                                                             |      |             |     |            |     |          |     |            |     |          |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|-----|------------|-----|----------|-----|------------|-----|----------|
| 31:23 | <b>BaseAddr[31:23]: base address.</b> Read-write.                                                                                                                                                                                                                                       |      |             |     |            |     |          |     |            |     |          |
| 22:4  | <b>BaseAddr[22:4]: base address.</b> Read-only.                                                                                                                                                                                                                                         |      |             |     |            |     |          |     |            |     |          |
| 3     | <b>Pref: prefetchable.</b> Read-only. 1=Prefetchable memory region.                                                                                                                                                                                                                     |      |             |     |            |     |          |     |            |     |          |
| 2:1   | <b>Type: base address register type.</b> Read-only.<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>32-bit BAR</td></tr> <tr> <td>01b</td><td>Reserved</td></tr> <tr> <td>10b</td><td>64-bit BAR</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table> | Bits | Description | 00b | 32-bit BAR | 01b | Reserved | 10b | 64-bit BAR | 11b | Reserved |
| Bits  | Description                                                                                                                                                                                                                                                                             |      |             |     |            |     |          |     |            |     |          |
| 00b   | 32-bit BAR                                                                                                                                                                                                                                                                              |      |             |     |            |     |          |     |            |     |          |
| 01b   | Reserved                                                                                                                                                                                                                                                                                |      |             |     |            |     |          |     |            |     |          |
| 10b   | 64-bit BAR                                                                                                                                                                                                                                                                              |      |             |     |            |     |          |     |            |     |          |
| 11b   | Reserved                                                                                                                                                                                                                                                                                |      |             |     |            |     |          |     |            |     |          |
| 0     | <b>MemSpace: memory space type.</b> Read-only. 0=Memory mapped base address.                                                                                                                                                                                                            |      |             |     |            |     |          |     |            |     |          |

**D1F0x1C Graphics Doorbell Base Address 64**

Reset: 0000\_0000h.

| Bits | Description                                                                                                                                                                |
|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:0 | <b>BaseAddr[63:32]: base address.</b> Read-write. This field is reserved if (D0F0xD4_x0109_14E1[StrapBifDoorbellBarDis]==1    D0F0xD4_x0109_14E2[StrapBifF064BarDisA]==1). |

**D1F0x20 Graphics IO Base Address**

Reset: 0000\_0000h. This register is called Base Address 4 if (D0F0xD4\_x0109\_14E2[StrapBifF064BarDisA]==1).

| Bits | Description |
|------|-------------|
| 31:0 | Reserved.   |

**D1F0x24 Graphics Memory Mapped Registers Base Address**

Reset: 0000\_0000h.

| Bits  | Description                                                                                                                                                                                           |
|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:16 | <b>BaseAddr[31:16]: base address.</b> Read-write. The amount of memory requested by the graphics memory mapped registers BAR is controlled by <a href="#">D0F0xD4_x0109_14E1</a> [StrapBifRegApSize]. |
| 15:4  | <b>BaseAddr[15:4]: base address.</b> Read-only.                                                                                                                                                       |
| 3     | <b>Pref: prefetchable.</b> Read-only. 0=Non-prefetchable memory region.                                                                                                                               |
| 2:1   | <b>Type: base address register type.</b> Read-only. 00b=32-bit BAR.                                                                                                                                   |
| 0     | <b>MemSpace: memory space type.</b> Read-only. 0=Memory mapped base address.                                                                                                                          |

**D1F0x2C Subsystem and Subvendor ID Register**Reset: 0000\_0000h. This register can be modified through [D1F0x4C](#)

| Bits  | Description                          |
|-------|--------------------------------------|
| 31:16 | <b>SubsystemID.</b> Read-only.       |
| 15:0  | <b>SubsystemVendorID.</b> Read-only. |

**D1F0x30 Expansion ROM Base Address**

Reset: 0000\_0000h.

| Bits | Description |
|------|-------------|
| 31:0 | Reserved.   |

**D1F0x34 Capabilities Pointer**

Reset: 0000\_0050h.

| Bits | Description                                                               |
|------|---------------------------------------------------------------------------|
| 31:8 | Reserved.                                                                 |
| 7:0  | <b>CapPtr: capabilities pointer.</b> Read-only. Pointer to PM capability. |

**D1F0x3C Interrupt Line**

Reset: 0000\_01FFh.

| Bits  | Description                                                                                                          |
|-------|----------------------------------------------------------------------------------------------------------------------|
| 31:16 | Reserved.                                                                                                            |
| 15:8  | <b>InterruptPin: interrupt pin.</b> Read-only. This field identifies the legacy interrupt message the function uses. |
| 7:0   | <b>InterruptLine: interrupt line.</b> Read-write. This field contains the interrupt line routing information.        |



**D1F0x4C Subsystem and Subvendor ID Mirror**

Reset: 0000\_0000h.

| Bits  | Description                                                                                                              |
|-------|--------------------------------------------------------------------------------------------------------------------------|
| 31:16 | <b>SubsystemID</b> . Read-write. This field sets the value in the corresponding field in <a href="#">D1F0x2C</a> .       |
| 15:0  | <b>SubsystemVendorID</b> . Read-write. This field sets the value in the corresponding field in <a href="#">D1F0x2C</a> . |

**D1F0x50 Power Management Capability**

| Bits  | Description                                                                                                                             |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------|
| 31:27 | <b>PmeSupport</b> . Value: 0_0000b. Indicates that there is no PME support.                                                             |
| 26    | <b>D2Support: D2 support</b> . Value: 1. D2 is supported                                                                                |
| 25    | <b>D1Support: D1 support</b> . Value: 1. D1 is supported                                                                                |
| 24:22 | <b>AuxCurrent: auxiliary current</b> . Value: 0.                                                                                        |
| 21    | <b>DevSpecificInit: device specific initialization</b> . Value: 0. Indicates that there is no device specific initialization necessary. |
| 20    | Reserved.                                                                                                                               |
| 19    | <b>PmeClock</b> . Value: 0.                                                                                                             |
| 18:16 | <b>Version: version</b> . Value: 011b.                                                                                                  |
| 15:8  | <b>NextPtr: next pointer</b> . Value: 58h                                                                                               |
| 7:0   | <b>CapID: capability ID</b> . Value: 01h. Indicates that the capability structure is a PCI power management data structure.             |

**D1F0x54 Power Management Control and Status**

Reset: 0000\_0000h.

| Bits  | Description                                                                                                                  |
|-------|------------------------------------------------------------------------------------------------------------------------------|
| 31:24 | <b>PmeData</b> . Read-only.                                                                                                  |
| 23    | <b>BusPwrEn</b> . Read-only.                                                                                                 |
| 22    | <b>B2B3Support</b> . Read-only. B states are not supported.                                                                  |
| 21:16 | Reserved.                                                                                                                    |
| 15    | <b>PmeStatus: PME status</b> . Read-only.                                                                                    |
| 14:13 | <b>DataScale: data scale</b> . Read-only.                                                                                    |
| 12:9  | <b>DataSelect: data select</b> . Read-only.                                                                                  |
| 8     | <b>PmeEn: PME# enable</b> . Read-only.                                                                                       |
| 7:4   | Reserved.                                                                                                                    |
| 3     | <b>NoSoftReset: no soft reset</b> . Read-only. Software is required to re-initialize the function when returning from D3hot. |

|             |                                                                                                                                                                                                                                                                                                                                      |             |                   |     |    |     |       |
|-------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|-------------------|-----|----|-----|-------|
| 2           | Reserved.                                                                                                                                                                                                                                                                                                                            |             |                   |     |    |     |       |
| 1:0         | <b>PowerState: power state.</b> Read-write. This 2-bit field is used both to determine the current power state of the root port and to set the root port into a new power state.<br><table> <tr> <td><u>Bits</u></td><td><u>Definition</u></td></tr> <tr> <td>00b</td><td>D0</td></tr> <tr> <td>11b</td><td>D3hot</td></tr> </table> | <u>Bits</u> | <u>Definition</u> | 00b | D0 | 11b | D3hot |
| <u>Bits</u> | <u>Definition</u>                                                                                                                                                                                                                                                                                                                    |             |                   |     |    |     |       |
| 00b         | D0                                                                                                                                                                                                                                                                                                                                   |             |                   |     |    |     |       |
| 11b         | D3hot                                                                                                                                                                                                                                                                                                                                |             |                   |     |    |     |       |

### D1F0x58 PCI Express Capability

| Bits  | Description                                                                                                                        |
|-------|------------------------------------------------------------------------------------------------------------------------------------|
| 31:30 | Reserved.                                                                                                                          |
| 29:25 | <b>IntMessageNum: interrupt message number.</b> Value: 0. This field indicates which MSI vector is used for the interrupt message. |
| 24    | <b>SlotImplemented: Slot implemented.</b> Value: 0.                                                                                |
| 23:20 | <b>DeviceType: device type.</b> Value: 9h.                                                                                         |
| 19:16 | <b>Version.</b> Value: 2h.                                                                                                         |
| 15:8  | <b>NextPtr: next pointer.</b> Value: Product-specific.                                                                             |
| 7:0   | <b>CapID: capability ID.</b> Value: 10h.                                                                                           |

### D1F0x5C Device Capability

| Bits  | Description                                                                                        |
|-------|----------------------------------------------------------------------------------------------------|
| 31:29 | Reserved.                                                                                          |
| 28    | <b>FlrCapable: function level reset capability.</b> Value: 0.                                      |
| 27:26 | <b>CapturedSlotPowerScale: captured slot power limit scale.</b> Value: 0.                          |
| 25:18 | <b>CapturedSlotPowerLimit: captured slot power limit value.</b> Value: 0.                          |
| 17:16 | Reserved.                                                                                          |
| 15    | <b>RoleBasedErrReporting: role-based error reporting.</b> Value: 1.                                |
| 14:12 | Reserved.                                                                                          |
| 11:9  | <b>L1AcceptableLatency: endpoint L1 Acceptable Latency.</b> Value: 111b.                           |
| 8:6   | <b>L0SAcceptableLatency: endpoint L0s Acceptable Latency.</b> Value: 110b.                         |
| 5     | <b>ExtendedTag: extended tag support.</b> Value: 1. 8 bit tag support.                             |
| 4:3   | <b>PhantomFunc: phantom function support.</b> Value: 0. No phantom functions supported.            |
| 2:0   | <b>MaxPayloadSupport: maximum supported payload size.</b> Value: 000b. 128 bytes max payload size. |

### D1F0x60 Device Control and Status

Reset: 0000\_0810h.

| Bits  | Description |
|-------|-------------|
| 31:22 | Reserved.   |

|       |                                                                                                                                                |
|-------|------------------------------------------------------------------------------------------------------------------------------------------------|
| 21    | <b>TransactionsPending:</b> transactions pending. Read-only.                                                                                   |
| 20    | <b>AuxPwr:</b> auxiliary power. Read-only.                                                                                                     |
| 19    | <b>UsrDetected:</b> unsupported request detected. Read; Write-1-to-clear. 1=Unsupported request received.                                      |
| 18    | <b>FatalErr:</b> fatal error detected. Read; Write-1-to-clear. 1=Fatal error detected.                                                         |
| 17    | <b>NonFatalErr:</b> non-fatal error detected. Read; Write-1-to-clear. 1=Non-fatal error detected.                                              |
| 16    | <b>CorrErr:</b> correctable error detected. Read; Write-1-to-clear. 1=Correctable error detected.                                              |
| 15    | <b>BridgeCfgRetryEn:</b> bridge configuration retry enable. Read-only.                                                                         |
| 14:12 | <b>MaxRequestSize:</b> maximum request size. Read-only.                                                                                        |
| 11    | <b>NoSnoopEnable:</b> enable no snoop. Read-write. 1=The device is permitted to set the No Snoop bit in requests.                              |
| 10    | <b>AuxPowerPmEn:</b> auxiliary power PM enable. Read-only. This capability is not implemented.                                                 |
| 9     | <b>PhantomFuncEn:</b> phantom functions enable. Read-only. Phantom functions are not supported.                                                |
| 8     | <b>ExtendedTagEn:</b> extended tag enable. Read-write. 1=8-bit tag request tags. 0=5-bit request tag.                                          |
| 7:5   | <b>MaxPayloadSize:</b> maximum supported payload size. Read-only. 000b=Indicates a 128 byte maximum payload size.                              |
| 4     | <b>RelaxedOrdEn:</b> relaxed ordering enable. Read-write. 1=The device is permitted to set the Relaxed Ordering bit.                           |
| 3     | <b>UsrReportEn:</b> unsupported request reporting enable. Read-write. 1=Enables signaling unsupported requests by sending error messages.      |
| 2     | <b>FatalErrEn:</b> fatal error reporting enable. Read-write. 1=Enables sending ERR_FATAL message when a fatal error is detected.               |
| 1     | <b>NonFatalErrEn:</b> non-fatal error reporting enable. Read-write. 1=Enables sending ERR_NONFATAL message when a non-fatal error is detected. |
| 0     | <b>CorrErrEn:</b> correctable error reporting enable. Read-write. 1=Enables sending ERR_CORR message when a correctable error is detected.     |

### D1F0x64 Link Capability

| Bits  | Description                                                                                                                           |
|-------|---------------------------------------------------------------------------------------------------------------------------------------|
| 31:24 | <b>PortNumber:</b> port number. Read-only. Value: 0. This field indicates the PCI Express port number for the given PCI Express link. |
| 23    | Reserved.                                                                                                                             |
| 22    | <b>AspmOptionalityCompliance:</b> ASP Optionality ECN capability. Read-only. Value: 0b.                                               |
| 21    | <b>LinkBWNotificationCap:</b> link bandwidth notification capability. Read-only. Value: 0b.                                           |
| 20    | <b>DLActiveReportingCapable:</b> data link layer active reporting capability. Read-only. Value: 0b.                                   |
| 19    | <b>SurpriseDownErrReporting:</b> surprise down error reporting capability. Read-only. Value: 0b.                                      |
| 18    | <b>ClockPowerManagement:</b> clock power management. Read-only. Value: 0b.                                                            |
| 17:15 | <b>L1ExitLatency:</b> L1 exit latency. Read-only. Value: 0b.                                                                          |
| 14:12 | <b>L0sExitLatency:</b> L0s exit latency. Read-only. Value: 0b.                                                                        |
| 11:10 | <b>PMSupport:</b> active state power management support. Read-only. Value: 0b.                                                        |

|     |                                                            |
|-----|------------------------------------------------------------|
| 9:4 | <b>LinkWidth: maximum link width.</b> Read-only. Value: 0. |
| 3:0 | <b>LinkSpeed: link speed.</b> Read-only. Value: 0b.        |

### D1F0x68 Link Control and Status

Reset: 0000\_0000h.

| Bits        | Description                                                                                                                                                                                                                                                                                                                                                                                                                                       |             |                           |             |                   |     |           |     |                   |     |                    |     |                           |
|-------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|---------------------------|-------------|-------------------|-----|-----------|-----|-------------------|-----|--------------------|-----|---------------------------|
| 31          | <b>LinkAutonomousBWStatus: link autonomous bandwidth status.</b> Read-only.                                                                                                                                                                                                                                                                                                                                                                       |             |                           |             |                   |     |           |     |                   |     |                    |     |                           |
| 30          | <b>LinkBWManagementStatus: link bandwidth management status.</b> Read-only.                                                                                                                                                                                                                                                                                                                                                                       |             |                           |             |                   |     |           |     |                   |     |                    |     |                           |
| 29          | <b>DLActive: data link layer link active.</b> Read-only. This bit indicates the status of the data link control and management state machine. Reads return a 1 to indicate the DL_Active state, otherwise 0 is returned.                                                                                                                                                                                                                          |             |                           |             |                   |     |           |     |                   |     |                    |     |                           |
| 28          | <b>SlotClockCfg: slot clock configuration.</b> Read-only. 1=the root port uses the same clock that the platform provides.                                                                                                                                                                                                                                                                                                                         |             |                           |             |                   |     |           |     |                   |     |                    |     |                           |
| 27          | <b>LinkTraining: link training.</b> Read-only. 1=Indicates that the physical layer link training state machine is in the configuration or recovery state, or that 1b was written to the RetrainLink bit but link training has not yet begun. Hardware clears this bit when the link training state machine exits the configuration/recovery state.                                                                                                |             |                           |             |                   |     |           |     |                   |     |                    |     |                           |
| 26          | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                         |             |                           |             |                   |     |           |     |                   |     |                    |     |                           |
| 25:20       | <b>NegotiatedLinkWidth: negotiated link width.</b> Read-only. This field indicates the negotiated width of the given PCI Express link.                                                                                                                                                                                                                                                                                                            |             |                           |             |                   |     |           |     |                   |     |                    |     |                           |
| 19:16       | <b>LinkSpeed: link speed.</b> Read-only.                                                                                                                                                                                                                                                                                                                                                                                                          |             |                           |             |                   |     |           |     |                   |     |                    |     |                           |
| 15:12       | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                         |             |                           |             |                   |     |           |     |                   |     |                    |     |                           |
| 11          | <b>LinkAutonomousBWIntEn: link autonomous bandwidth interrupt enable.</b> Read-only.                                                                                                                                                                                                                                                                                                                                                              |             |                           |             |                   |     |           |     |                   |     |                    |     |                           |
| 10          | <b>LinkBWManagementEn: link bandwidth management interrupt enable.</b> Read-only.                                                                                                                                                                                                                                                                                                                                                                 |             |                           |             |                   |     |           |     |                   |     |                    |     |                           |
| 9           | <b>HWAutonomousWidthDisable: hardware autonomous width disable.</b> Read-only. 1=Hardware not allowed to change the link width except to correct unreliable link operation by reducing link width.                                                                                                                                                                                                                                                |             |                           |             |                   |     |           |     |                   |     |                    |     |                           |
| 8           | <b>ClockPowerManagementEn: clock power management enable.</b> Read-only.                                                                                                                                                                                                                                                                                                                                                                          |             |                           |             |                   |     |           |     |                   |     |                    |     |                           |
| 7           | <b>ExtendedSync: extended sync.</b> Read-only. 1=Forces the transmission of additional ordered sets when exiting the L0s state and when in the recovery state.                                                                                                                                                                                                                                                                                    |             |                           |             |                   |     |           |     |                   |     |                    |     |                           |
| 6           | <b>CommonClockCfg: common clock configuration.</b> Read-only. 1=Indicates that the root port and the component at the opposite end of this Link are operating with a distributed common reference clock. 0=Indicates that the upstream port and the component at the opposite end of this Link are operating with asynchronous reference clock.                                                                                                   |             |                           |             |                   |     |           |     |                   |     |                    |     |                           |
| 5           | <b>RetrainLink: retrain link.</b> Read-only. This bit does not apply to endpoints.                                                                                                                                                                                                                                                                                                                                                                |             |                           |             |                   |     |           |     |                   |     |                    |     |                           |
| 4           | <b>LinkDis: link disable.</b> Read-only. This bit does not apply to endpoints.                                                                                                                                                                                                                                                                                                                                                                    |             |                           |             |                   |     |           |     |                   |     |                    |     |                           |
| 3           | <b>ReadCplBoundary: read completion boundary.</b> Read-only. 0=64 byte read completion boundary.                                                                                                                                                                                                                                                                                                                                                  |             |                           |             |                   |     |           |     |                   |     |                    |     |                           |
| 2           | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                         |             |                           |             |                   |     |           |     |                   |     |                    |     |                           |
| 1:0         | <b>PmControl: active state power management enable.</b> Read-only. This field controls the level of ASPM supported on the given PCI Express link. <table><tr><td><u>Bits</u></td><td><u>Definition</u></td><td><u>Bits</u></td><td><u>Definition</u></td></tr><tr><td>00b</td><td>Disabled.</td><td>10b</td><td>L1 Entry Enabled.</td></tr><tr><td>01b</td><td>L0s Entry Enabled.</td><td>11b</td><td>L0s and L1 Entry Enabled.</td></tr></table> | <u>Bits</u> | <u>Definition</u>         | <u>Bits</u> | <u>Definition</u> | 00b | Disabled. | 10b | L1 Entry Enabled. | 01b | L0s Entry Enabled. | 11b | L0s and L1 Entry Enabled. |
| <u>Bits</u> | <u>Definition</u>                                                                                                                                                                                                                                                                                                                                                                                                                                 | <u>Bits</u> | <u>Definition</u>         |             |                   |     |           |     |                   |     |                    |     |                           |
| 00b         | Disabled.                                                                                                                                                                                                                                                                                                                                                                                                                                         | 10b         | L1 Entry Enabled.         |             |                   |     |           |     |                   |     |                    |     |                           |
| 01b         | L0s Entry Enabled.                                                                                                                                                                                                                                                                                                                                                                                                                                | 11b         | L0s and L1 Entry Enabled. |             |                   |     |           |     |                   |     |                    |     |                           |

**D1F0x7C Device Capability 2**

Reset: 0000\_0000h.

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                       |      |                         |      |            |     |                         |     |                         |     |                       |     |                         |
|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------------------|------|------------|-----|-------------------------|-----|-------------------------|-----|-----------------------|-----|-------------------------|
| 31:24 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                         |      |                         |      |            |     |                         |     |                         |     |                       |     |                         |
| 23:22 | <b>MaxEndEndTlpPrefixes: Max number of End-End TLP prefixes supported.</b> Read-only. IF (D1F0x7C[EndEndTlpPrefixSupported]==0) THEN Reserved. ENDIF.<br><table><tr><th>Bits</th><th>Definition</th><th>Bits</th><th>Definition</th></tr><tr><td>00b</td><td>4 End-End TLP Prefixes.</td><td>10b</td><td>2 End-End TLP Prefixes.</td></tr><tr><td>01b</td><td>1 End-End TLP Prefix.</td><td>11b</td><td>3 End-End TLP Prefixes.</td></tr></table> | Bits | Definition              | Bits | Definition | 00b | 4 End-End TLP Prefixes. | 10b | 2 End-End TLP Prefixes. | 01b | 1 End-End TLP Prefix. | 11b | 3 End-End TLP Prefixes. |
| Bits  | Definition                                                                                                                                                                                                                                                                                                                                                                                                                                        | Bits | Definition              |      |            |     |                         |     |                         |     |                       |     |                         |
| 00b   | 4 End-End TLP Prefixes.                                                                                                                                                                                                                                                                                                                                                                                                                           | 10b  | 2 End-End TLP Prefixes. |      |            |     |                         |     |                         |     |                       |     |                         |
| 01b   | 1 End-End TLP Prefix.                                                                                                                                                                                                                                                                                                                                                                                                                             | 11b  | 3 End-End TLP Prefixes. |      |            |     |                         |     |                         |     |                       |     |                         |
| 21    | <b>EndEndTlpPrefixSupported: End-End TLP Prefix supported.</b> Read-only.                                                                                                                                                                                                                                                                                                                                                                         |      |                         |      |            |     |                         |     |                         |     |                       |     |                         |
| 20    | <b>ExtendedFmtFieldSupported.</b> Read-only. 1=Function supports 3-bit definition of Fmt field. 0=Function supports 2-bit definition of Fmt field.                                                                                                                                                                                                                                                                                                |      |                         |      |            |     |                         |     |                         |     |                       |     |                         |
| 19:18 | <b>ObffSupported: Optimized buffer flush/fill supported.</b> Read-only.                                                                                                                                                                                                                                                                                                                                                                           |      |                         |      |            |     |                         |     |                         |     |                       |     |                         |
| 17:14 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                         |      |                         |      |            |     |                         |     |                         |     |                       |     |                         |
| 13:12 | <b>TphCplrSupported.</b> Read-only.                                                                                                                                                                                                                                                                                                                                                                                                               |      |                         |      |            |     |                         |     |                         |     |                       |     |                         |
| 11    | <b>LtrSupported: Latency Tolerance Reporting supported.</b> Read-only.                                                                                                                                                                                                                                                                                                                                                                            |      |                         |      |            |     |                         |     |                         |     |                       |     |                         |
| 10    | <b>NoRoEnabledP2pPassing.</b> Read-only.                                                                                                                                                                                                                                                                                                                                                                                                          |      |                         |      |            |     |                         |     |                         |     |                       |     |                         |
| 9:6   | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                         |      |                         |      |            |     |                         |     |                         |     |                       |     |                         |
| 5     | <b>AriForwardingSupported: ARI forwarding supported.</b> Read-only.                                                                                                                                                                                                                                                                                                                                                                               |      |                         |      |            |     |                         |     |                         |     |                       |     |                         |
| 4     | <b>CplTimeoutDisSupported: completion timeout disable supported.</b> Read-only.                                                                                                                                                                                                                                                                                                                                                                   |      |                         |      |            |     |                         |     |                         |     |                       |     |                         |
| 3:0   | <b>CplTimeoutRangeSupported: completion timeout range supported.</b> Read-only.                                                                                                                                                                                                                                                                                                                                                                   |      |                         |      |            |     |                         |     |                         |     |                       |     |                         |

**D1F0x80 Device Control and Status 2**

Reset: 0000\_0000h.

| Bits  | Description                                                            |
|-------|------------------------------------------------------------------------|
| 31:16 | Reserved.                                                              |
| 15    | <b>EndEndTlpPrefixBlocking.</b> Read-only.                             |
| 14:13 | <b>ObffEn.</b> Read-only.                                              |
| 12:11 | Reserved.                                                              |
| 10    | <b>LtrEn.</b> Read-only.                                               |
| 9     | <b>IdoCompletionEn.</b> Read-only.                                     |
| 8     | <b>IdoRequestEn.</b> Read-only.                                        |
| 7:6   | Reserved.                                                              |
| 5     | <b>AriForwardingEn.</b> Read-only.                                     |
| 4     | <b>CplTimeoutDis: completion timeout disable.</b> Read-only.           |
| 3:0   | <b>CplTimeoutValue: completion timeout range supported.</b> Read-only. |

**D1F0x84 Link Capability 2**

| Bits | Description                                                                                                                                                            |
|------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:9 | Reserved.                                                                                                                                                              |
| 8    | <b>CrosslinkSupported: Crosslink Supported.</b> Read-only. Reset: 0. 1=Crosslink supported.                                                                            |
| 7:1  | <b>SupportedLinkSpeed: Supported Link Speed.</b> Read-only. Reset: 07h. Specifies what link speeds are supported. Bit 1 = 2.5 GT/s, Bit2 = 5.0 Gt/s, Bit 3 = 8.0 GT/s. |
| 0    | Reserved.                                                                                                                                                              |

**D1F0x88 Link Control and Status 2**

Reset: 0000\_0000h.

| Bits  | Description                                                                                                                                       |
|-------|---------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:22 | Reserved.                                                                                                                                         |
| 21    | <b>LinkEqualizationRequest.</b> Read-only. Set when hardware requests link equalization to be performed.                                          |
| 20    | <b>EqualizationPhase3Success: Phase3 of Tx equalization procedure completed.</b> Read-only.                                                       |
| 19    | <b>EqualizationPhase2Success: Phase2 of Tx equalization procedure completed.</b> Read-only.                                                       |
| 18    | <b>EqualizationPhase1Success: Phase1 of Tx equalization procedure completed.</b> Read-only.                                                       |
| 17    | <b>EqualizationComplete: Tx equalization procedure completed.</b> Read-only.                                                                      |
| 16    | <b>CurDeemphasisLevel: current deemphasis level.</b> Read-only. 1=-3.5 dB. 0=-6 dB.                                                               |
| 15:13 | Reserved.                                                                                                                                         |
| 12    | <b>ComplianceDeemphasis: compliance deemphasis.</b> Read-only. This bit defines the deemphasis level used in compliance mode. 1=-3.5 dB. 0=-6 dB. |
| 11    | <b>ComplianceSOS: compliance SOS.</b> Read-only. 1=The device transmits skip ordered sets in between the modified compliance pattern.             |
| 10    | <b>EnterModCompliance: enter modified compliance.</b> Read-only. 1=The device transmits modified compliance pattern.                              |
| 9:7   | <b>XmitMargin: transmit margin.</b> Read-only. This field controls the non-deemphasized voltage level at the transmitter pins.                    |
| 6     | <b>SelectableDeemphasis: selectable deemphasis.</b> Read-only.                                                                                    |
| 5     | <b>HwAutonomousSpeedDisable: hardware autonomous speed disable.</b> Read-only. 1=Disables hardware generated link speed changes.                  |
| 4     | <b>EnterCompliance: enter compliance.</b> Read-only. 1=Force link to enter compliance mode.                                                       |
| 3:0   | <b>TargetLinkSpeed: target link speed.</b> Read-only. This field defines the upper limit of the link operational speed.                           |

**D1F0xA0 MSI Capability**

| Bits  | Description |
|-------|-------------|
| 31:24 | Reserved.   |

|       |                                                                                                                                                                                                                                                                             |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 23    | <b>Msi64bit: MSI 64 bit capability.</b> Read-only. Reset: 1. 1=The device is capable of sending 64-bit MSI messages. 0=The device is not capable of sending a 64-bit message address.                                                                                       |
| 22:20 | <b>MsiMultiEn: MSI multiple message enable.</b> Read-write. Reset: 000b. Software writes to this field to indicate the number of allocated vectors (equal to or less than the number of requested vectors). When MSI is enabled, a function is allocated at least 1 vector. |
| 19:17 | <b>MsiMultiCap: MSI multiple message capability.</b> Read-only. Reset: 000b. 000b=The device is requesting one vector.                                                                                                                                                      |
| 16    | <b>MsiEn: MSI enable.</b> Read-write. Reset: 0. 1=MSI generation is enabled and INTx generation is disabled. 0=MSI generation disabled and INTx generation is enabled.                                                                                                      |
| 15:8  | <b>NextPtr: next pointer.</b> Read-only. Reset:00h                                                                                                                                                                                                                          |
| 7:0   | <b>CapID: capability ID.</b> Read-only. Reset: 05h. 05h=MSI capability structure.                                                                                                                                                                                           |

### D1F0xA4 MSI Message Address Low

Reset: 0000\_0000h.

| Bits | Description                                                                                                                                   |
|------|-----------------------------------------------------------------------------------------------------------------------------------------------|
| 31:2 | <b>MsiMsgAddrLo: MSI message address.</b> Read-write. This register specifies the dword aligned address for the MSI memory write transaction. |
| 1:0  | Reserved.                                                                                                                                     |

### D1F0xA8 MSI Message Address High

Reset: 0000\_0000h.

| Bits | Description                                                                                                                           |
|------|---------------------------------------------------------------------------------------------------------------------------------------|
| 31:8 | Reserved.                                                                                                                             |
| 7:0  | <b>MsiMsgAddrHi: MSI message address.</b> Read-write. This register specifies the upper 8-bits of the MSI address in 64 bit MSI mode. |

### D1F0xAC MSI Message Data

Reset: 0000\_0000h.

| Bits  | Description                                                                                                                                                       |
|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:16 | Reserved.                                                                                                                                                         |
| 15:0  | <b>MsiData: MSI message data.</b> Read-write. This register specifies lower 16 bits of data for the MSI memory write transaction. The upper 16 bits are always 0. |

### D1F0x100 Vendor Specific Enhanced Capability

Reset: 0061\_000Bh.

| Bits  | Description                              |
|-------|------------------------------------------|
| 31:20 | <b>NextPtr: next pointer.</b> Read-only. |

|       |                                               |
|-------|-----------------------------------------------|
| 19:16 | <b>CapVer: capability version.</b> Read-only. |
| 15:0  | <b>CapID: capability ID.</b> Read-only.       |

### D1F0x104 Vendor Specific Header

Reset: 0101\_0001h.

| Bits  | Description                                                             |
|-------|-------------------------------------------------------------------------|
| 31:20 | <b>VsecLen: vendor specific enhanced next pointer.</b> Read-only.       |
| 19:16 | <b>VsecRev: vendor specific enhanced capability version.</b> Read-only. |
| 15:0  | <b>VsecID: vendor specific enhanced capability ID.</b> Read-only.       |

### D1F0x108 Vendor Specific 1

Reset: 0000\_0000h.

| Bits | Description                          |
|------|--------------------------------------|
| 31:0 | <b>Scratch: scratch.</b> Read-write. |

### D1F0x10C Vendor Specific 2

Reset: 0000\_0000h.

| Bits | Description                          |
|------|--------------------------------------|
| 31:0 | <b>Scratch: scratch.</b> Read-write. |



### 3.6 Device 1 Function 1 (Audio Controller) Configuration Registers

See 3.1 [Register Descriptions and Mnemonics] for a description of the register naming convention. See 2.7 [Configuration Space] for details about how to access this space.

#### D1F1x00 Device/Vendor ID

| Bits  | Description                                                       |
|-------|-------------------------------------------------------------------|
| 31:16 | <b>DeviceID: device ID.</b> Read-only. Value: Product-specific. . |
| 15:0  | <b>VendorID: vendor ID.</b> Read-only. Value: 1002h.              |

#### D1F1x04 Status/Command

Reset: 0010\_0000h.

| Bits  | Description                                                                                                                                                                      |
|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31    | <b>ParityErrorDetected: detected parity error.</b> Read; Write-1-to-clear. 1=Poisoned TLP received.                                                                              |
| 30    | <b>SignaledSystemError: signaled system error.</b> Read; Write-1-to-clear. 1=A non-fatal or fatal error message was sent and SerrEn=1.                                           |
| 29    | <b>ReceivedMasterAbort: received master abort.</b> Read; Write-1-to-clear. 1=A completion with an unsupported request completion status was received.                            |
| 28    | <b>ReceivedTargetAbort: received target abort.</b> Read; Write-1-to-clear. 1=A completion with completer abort completion status was received.                                   |
| 27    | <b>SignalTargetAbort: Signaled target abort.</b> Read-only.                                                                                                                      |
| 26:25 | <b>DevselTiming: DEVSEL# Timing.</b> Read-only.                                                                                                                                  |
| 24    | <b>MasterDataPerr: master data parity error.</b> Read; Write-1-to-clear. 1=ParityErrorEn=1 and either a poisoned completion was received or the device poisoned a write request. |
| 23    | <b>FastBackCapable: fast back-to-back capable.</b> Read-only.                                                                                                                    |
| 22    | <b>UDFEn: UDF enable.</b> Read-only.                                                                                                                                             |
| 21    | <b>PCI66En: 66 MHz capable.</b> Read-only.                                                                                                                                       |
| 20    | <b>CapList: capability list.</b> Read-only. 1=capability list supported.                                                                                                         |
| 19    | <b>IntStatus: interrupt status.</b> Read-only. 1=INTx interrupt message pending.                                                                                                 |
| 18:11 | Reserved.                                                                                                                                                                        |
| 10    | <b>IntDis: interrupt disable.</b> Read-write. 1=INTx interrupt messages generation disabled.                                                                                     |
| 9     | <b>FastB2BEn: fast back-to-back enable.</b> Read-only.                                                                                                                           |
| 8     | <b>SerrEn: System error enable.</b> Read-write. 1=Enables reporting of non-fatal and fatal errors detected.                                                                      |
| 7     | <b>Stepping: Stepping control.</b> Read-only.                                                                                                                                    |
| 6     | <b>ParityErrorEn: parity error response enable.</b> Read-write.                                                                                                                  |
| 5     | <b>PalSnoopEn: VGA palette snoop enable.</b> Read-only.                                                                                                                          |

|   |                                                                                                                                                   |
|---|---------------------------------------------------------------------------------------------------------------------------------------------------|
| 4 | <b>MemWriteInvalidateEn: memory write and invalidate enable.</b> Read-only.                                                                       |
| 3 | <b>SpecialCycleEn: special cycle enable.</b> Read-only.                                                                                           |
| 2 | <b>BusMasterEn: bus master enable.</b> Read-write. 1=Memory and IO read and write request generation enabled.                                     |
| 1 | <b>MemAccessEn: IO access enable.</b> Read-write. This bit controls if memory accesses targeting this device are accepted. 1=Enabled. 0=Disabled. |
| 0 | <b>IoAccessEn: IO access enable.</b> Read-write. This bit controls if IO accesses targeting this device are accepted. 1=Enabled. 0=Disabled.      |

#### D1F1x08 Class Code/Revision ID

Reset: 0403\_0000h.

| Bits | Description                           |
|------|---------------------------------------|
| 31:8 | <b>ClassCode.</b> Read-only.          |
| 7:0  | <b>RevID: revision ID.</b> Read-only. |

#### D1F1x0C Header Type

Reset: 0080\_0000h.

| Bits  | Description                                                                                                 |
|-------|-------------------------------------------------------------------------------------------------------------|
| 31:24 | <b>BIST.</b> Read-only. These bits are fixed at their default values.                                       |
| 23:16 | <b>HeaderTypeReg.</b> Read-only. 80h=Type 0 multi-function device.                                          |
| 15:8  | <b>LatencyTimer.</b> Read-only. These bits are fixed at their default value.                                |
| 7:0   | <b>CacheLineSize.</b> Read-write. This field specifies the system cache line size in units of double words. |

#### D1F1x10 Audio Registers Base Address

Reset: 0000\_0000h.

| Bits  | Description                                                                           |
|-------|---------------------------------------------------------------------------------------|
| 31:14 | <b>BaseAddr: base address.</b> Read-write.                                            |
| 13:4  | Reserved.                                                                             |
| 3     | <b>Pref: prefetchable.</b> Read-only. 0=Non-prefetchable memory region.               |
| 2:1   | <b>Type: base address register type.</b> Read-only. 00b=32-bit base address register. |
| 0     | <b>MemSpace: memory space type.</b> Read-only. 0=Memory mapped base address.          |

#### D1F1x14 Base Address 1

Reset: 0000\_0000h.

| Bits | Description |
|------|-------------|
| 31:0 | Reserved.   |

**D1F1x18 Base Address 2**

Reset: 0000\_0000h.

| Bits | Description |
|------|-------------|
| 31:0 | Reserved.   |

**D1F1x1C Base Address 3**

Reset: 0000\_0000h.

| Bits | Description |
|------|-------------|
| 31:0 | Reserved.   |

**D1F1x20 Base Address 4**

Reset: 0000\_0000h.

| Bits | Description |
|------|-------------|
| 31:0 | Reserved.   |

**D1F1x24 Base Address 5**

Reset: 0000\_0000h.

| Bits | Description |
|------|-------------|
| 31:0 | Reserved.   |

**D1F1x2C Subsystem and Subvendor ID**Reset: 0000\_0000h. This register can be modified through [D1F1x4C](#).

| Bits  | Description                           |
|-------|---------------------------------------|
| 31:16 | <b>SubsystemID</b> . Read-only.       |
| 15:0  | <b>SubsystemVendorID</b> . Read-only. |

**D1F1x30 Expansion ROM Base Address**

Reset: 0000\_0000h.

| Bits | Description |
|------|-------------|
| 31:0 | Reserved.   |

**D1F1x34 Capabilities Pointer**

Reset: 0000\_0050h.

| Bits | Description                                                               |
|------|---------------------------------------------------------------------------|
| 31:8 | Reserved.                                                                 |
| 7:0  | <b>CapPtr: capabilities pointer.</b> Read-only. Pointer to PM capability. |

**D1F1x3C Interrupt Line**

Reset: 0000\_02FFh.

| Bits  | Description                                                                                                          |
|-------|----------------------------------------------------------------------------------------------------------------------|
| 31:16 | Reserved.                                                                                                            |
| 15:8  | <b>InterruptPin: interrupt pin.</b> Read-only. This field identifies the legacy interrupt message the function uses. |
| 7:0   | <b>InterruptLine: interrupt line.</b> Read-write. This field contains the interrupt line routing information.        |

**D1F1x4C Subsystem and Subvendor ID Mirror**

Reset: 0000\_0000h.

| Bits  | Description                                                                                                             |
|-------|-------------------------------------------------------------------------------------------------------------------------|
| 31:16 | <b>SubsystemID.</b> Read-write. This field sets the value in the corresponding field in <a href="#">D1F1x2C</a> .       |
| 15:0  | <b>SubsystemVendorID.</b> Read-write. This field sets the value in the corresponding field in <a href="#">D1F1x2C</a> . |

**D1F1x50 Power Management Capability**

| Bits  | Description                                                                                                                            |
|-------|----------------------------------------------------------------------------------------------------------------------------------------|
| 31:27 | <b>PmeSupport.</b> Value: 0_0000b. Indicates that there is no PME support.                                                             |
| 26    | <b>D2Support: D2 support.</b> Value: 1. D2 is supported                                                                                |
| 25    | <b>D1Support: D1 support.</b> Value: 1. D1 is supported                                                                                |
| 24:22 | <b>AuxCurrent: auxiliary current.</b> Value: 0.                                                                                        |
| 21    | <b>DevSpecificInit: device specific initialization.</b> Value: 0. Indicates that there is no device specific initialization necessary. |
| 20    | Reserved.                                                                                                                              |
| 19    | <b>PmeClock.</b> Value: 0.                                                                                                             |
| 18:16 | <b>Version: version.</b> Value: 011b.                                                                                                  |
| 15:8  | <b>NextPtr: next pointer.</b> Value: 00h.                                                                                              |
| 7:0   | <b>CapID: capability ID.</b> Value: 01h. Indicates that the capability structure is a PCI power management data structure.             |

**D1F1x54 Power Management Control and Status**

Reset: 0000\_0000h.

| Bits     | Description                                                                                                                                                                                                                                                                                                                                                                  |      |            |     |    |          |          |     |       |
|----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------------|-----|----|----------|----------|-----|-------|
| 31:24    | <b>PmeData</b> : Read-only.                                                                                                                                                                                                                                                                                                                                                  |      |            |     |    |          |          |     |       |
| 23       | <b>BusPwrEn</b> : Read-only.                                                                                                                                                                                                                                                                                                                                                 |      |            |     |    |          |          |     |       |
| 22       | <b>B2B3Support</b> : Read-only. B states are not supported.                                                                                                                                                                                                                                                                                                                  |      |            |     |    |          |          |     |       |
| 21:16    | Reserved.                                                                                                                                                                                                                                                                                                                                                                    |      |            |     |    |          |          |     |       |
| 15       | <b>PmeStatus</b> : <b>PME status</b> . Read-only.                                                                                                                                                                                                                                                                                                                            |      |            |     |    |          |          |     |       |
| 14:13    | <b>DataScale</b> : <b>data scale</b> . Read-only.                                                                                                                                                                                                                                                                                                                            |      |            |     |    |          |          |     |       |
| 12:9     | <b>DataSelect</b> : <b>data select</b> . Read-only.                                                                                                                                                                                                                                                                                                                          |      |            |     |    |          |          |     |       |
| 8        | <b>PmeEn</b> : <b>PME# enable</b> . Read-only.                                                                                                                                                                                                                                                                                                                               |      |            |     |    |          |          |     |       |
| 7:4      | Reserved.                                                                                                                                                                                                                                                                                                                                                                    |      |            |     |    |          |          |     |       |
| 3        | <b>NoSoftReset</b> : <b>no soft reset</b> . Read-only. Software is required to re-initialize the function when returning from D3 <sub>hot</sub> .                                                                                                                                                                                                                            |      |            |     |    |          |          |     |       |
| 2        | Reserved.                                                                                                                                                                                                                                                                                                                                                                    |      |            |     |    |          |          |     |       |
| 1:0      | <b>PowerState</b> : <b>power state</b> . Read-write. This 2-bit field is used both to determine the current power state of the root port and to set the root port into a new power state.<br><table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>00b</td><td>D0</td></tr> <tr> <td>01b, 10b</td><td>Reserved</td></tr> <tr> <td>11b</td><td>D3hot</td></tr> </table> | Bits | Definition | 00b | D0 | 01b, 10b | Reserved | 11b | D3hot |
| Bits     | Definition                                                                                                                                                                                                                                                                                                                                                                   |      |            |     |    |          |          |     |       |
| 00b      | D0                                                                                                                                                                                                                                                                                                                                                                           |      |            |     |    |          |          |     |       |
| 01b, 10b | Reserved                                                                                                                                                                                                                                                                                                                                                                     |      |            |     |    |          |          |     |       |
| 11b      | D3hot                                                                                                                                                                                                                                                                                                                                                                        |      |            |     |    |          |          |     |       |

**D1F1x58 PCI Express Capability**

| Bits  | Description                                                                                                                                 |
|-------|---------------------------------------------------------------------------------------------------------------------------------------------|
| 31:30 | Reserved.                                                                                                                                   |
| 29:25 | <b>IntMessageNum</b> : <b>interrupt message number</b> . Value: 0. This field indicates which MSI vector is used for the interrupt message. |
| 24    | <b>SlotImplemented</b> : <b>Slot implemented</b> . Value: 0.                                                                                |
| 23:20 | <b>DeviceType</b> : <b>device type</b> . Value: 9h.                                                                                         |
| 19:16 | <b>Version</b> . Value: 2h.                                                                                                                 |
| 15:8  | <b>NextPtr</b> : <b>next pointer</b> . Value: Product-specific.                                                                             |
| 7:0   | <b>CapID</b> : <b>capability ID</b> . Value: 10h.                                                                                           |

**D1F1x5C Device Capability**

| Bits  | Description                                                                           |
|-------|---------------------------------------------------------------------------------------|
| 31:29 | Reserved.                                                                             |
| 28    | <b>FlrCapable</b> : <b>function level reset capability</b> . Value: Product-specific. |
| 27:26 | <b>CapturedSlotPowerScale</b> : <b>captured slot power limit scale</b> . Value: 0.    |

|       |                                                                                                    |
|-------|----------------------------------------------------------------------------------------------------|
| 25:18 | <b>CapturedSlotPowerLimit:</b> captured slot power limit value. Value: 0.                          |
| 17:16 | Reserved.                                                                                          |
| 15    | <b>RoleBasedErrReporting:</b> role-based error reporting. Value: 1.                                |
| 14:12 | Reserved.                                                                                          |
| 11:9  | <b>L1AcceptableLatency:</b> endpoint L1 Acceptable Latency. Value: 111b.                           |
| 8:6   | <b>L0SAcceptableLatency:</b> endpoint L0s Acceptable Latency. Value: 110b.                         |
| 5     | <b>ExtendedTag:</b> extended tag support. Value: 1. 8 bit tag support.                             |
| 4:3   | <b>PhantomFunc:</b> phantom function support. Value: 0. No phantom functions supported.            |
| 2:0   | <b>MaxPayloadSupport:</b> maximum supported payload size. Value: 000b. 128 bytes max payload size. |

### D1F1x60 Device Control and Status

Reset: 0000\_0810h.

| Bits  | Description                                                                                                                               |
|-------|-------------------------------------------------------------------------------------------------------------------------------------------|
| 31:22 | Reserved.                                                                                                                                 |
| 21    | <b>TransactionsPending:</b> transactions pending. Read-only.                                                                              |
| 20    | <b>AuxPwr:</b> auxiliary power. Read-only.                                                                                                |
| 19    | <b>UsrDetected:</b> unsupported request detected. Read; Write-1-to-clear. 1=Unsupported request received.                                 |
| 18    | <b>FatalErr:</b> fatal error detected. Read; Write-1-to-clear. 1=Fatal error detected.                                                    |
| 17    | <b>NonFatalErr:</b> non-fatal error detected. Read; Write-1-to-clear. 1=Non-fatal error detected.                                         |
| 16    | <b>CorrErr:</b> correctable error detected. Read; Write-1-to-clear. 1=Correctable error detected.                                         |
| 15    | <b>BridgeCfgRetryEn:</b> bridge configuration retry enable. Read-only.                                                                    |
| 14:12 | <b>MaxRequestSize:</b> maximum request size. Read-only. 0=The root port never generates read requests with size exceeding 128 bytes.      |
| 11    | <b>NoSnoopEnable:</b> enable no snoop. Read-write. 1=The device is permitted to set the No Snoop bit in requests.                         |
| 10    | <b>AuxPowerPmEn:</b> auxiliary power PM enable. Read-only. This capability is not implemented.                                            |
| 9     | <b>PhantomFuncEn:</b> phantom functions enable. Read-only. Phantom functions are not supported.                                           |
| 8     | <b>ExtendedTagEn:</b> extended tag enable. Read-write. 1=8-bit tag request tags. 0=5-bit request tag.                                     |
| 7:5   | <b>MaxPayloadSize:</b> maximum supported payload size. Read-only. 000b=Indicates a 128 byte maximum payload size.                         |
| 4     | <b>RelaxedOrdEn:</b> relaxed ordering enable. Read-write. 1=The device is permitted to set the Relaxed Ordering bit.                      |
| 3     | <b>UsrReportEn:</b> unsupported request reporting enable. Read-write. 1=Enables signaling unsupported requests by sending error messages. |
| 2     | <b>FatalErrEn:</b> fatal error reporting enable. Read-write. 1=Enables sending ERR_FATAL message when a fatal error is detected.          |

|   |                                                                                                                                                |
|---|------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | <b>NonFatalErrEn: non-fatal error reporting enable.</b> Read-write. 1=Enables sending ERR_NONFATAL message when a non-fatal error is detected. |
| 0 | <b>CorrErrEn: correctable error reporting enable.</b> Read-write. 1=Enables sending ERR_CORR message when a correctable error is detected.     |

### D1F1x64 Link Capability

| Bits  | Description                                                                                                                |
|-------|----------------------------------------------------------------------------------------------------------------------------|
| 31:24 | <b>PortNumber: port number.</b> Value: 0. This field indicates the PCI Express port number for the given PCI Express link. |
| 23:22 | Reserved.                                                                                                                  |
| 21    | <b>LinkBWNotificationCap: link bandwidth notification capability.</b> Read-only. Value: 0b.                                |
| 20    | <b>DLActiveReportingCapable: data link layer active reporting capability.</b> Read-only. Value: 0b.                        |
| 19    | <b>SurpriseDownErrReporting: surprise down error reporting capability.</b> Read-only. Value: 0b.                           |
| 18    | <b>ClockPowerManagement: clock power management.</b> Read-only. Value: 0b.                                                 |
| 17:15 | <b>L1ExitLatency: L1 exit latency.</b> Read-only. Value: 0b.                                                               |
| 14:12 | <b>L0sExitLatency: L0s exit latency.</b> Read-only. Value: 0b.                                                             |
| 11:10 | <b>PMSupport: active state power management support.</b> Read-only. Value: 0b.                                             |
| 9:4   | <b>LinkWidth: maximum link width.</b> Read-only. Value: 0.                                                                 |
| 3:0   | <b>LinkSpeed: link speed.</b> Read-only. Value: 0b.                                                                        |

### D1F1x68 Link Control and Status

Reset: 0000\_0000h.

| Bits  | Description                                                                                                                                                                                                                                                                                                                                        |
|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31    | <b>LinkAutonomousBWStatus: link autonomous bandwidth status.</b> Read-only.                                                                                                                                                                                                                                                                        |
| 30    | <b>LinkBWManagementStatus: link bandwidth management status.</b> Read-only.                                                                                                                                                                                                                                                                        |
| 29    | <b>DLActive: data link layer link active.</b> Read-only. This bit indicates the status of the data link control and management state machine. Reads return a 1 to indicate the DL_Active state, otherwise 0 is returned.                                                                                                                           |
| 28    | <b>SlotClockCfg: slot clock configuration.</b> Read-only. 1=The root port uses the same clock that the platform provides.                                                                                                                                                                                                                          |
| 27    | <b>LinkTraining: link training.</b> Read-only. 1=Indicates that the physical layer link training state machine is in the configuration or recovery state, or that 1b was written to the RetrainLink bit but link training has not yet begun. Hardware clears this bit when the link training state machine exits the configuration/recovery state. |
| 26    | Reserved.                                                                                                                                                                                                                                                                                                                                          |
| 25:20 | <b>NegotiatedLinkWidth: negotiated link width.</b> Read-only. This field indicates the negotiated width of the given PCI Express link.                                                                                                                                                                                                             |

|             |                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                    |                           |  |             |                   |                    |                   |     |           |          |                   |     |                    |           |                           |    |  |         |  |       |  |          |  |
|-------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|---------------------------|--|-------------|-------------------|--------------------|-------------------|-----|-----------|----------|-------------------|-----|--------------------|-----------|---------------------------|----|--|---------|--|-------|--|----------|--|
| 19:16       | <b>LinkSpeed: link speed.</b> Read-only.<br><table><tr><td><u>Bits</u></td><td></td><td><u>Description</u></td><td></td></tr><tr><td>0h</td><td></td><td>Reserved</td><td></td></tr><tr><td>1h</td><td></td><td>2.5 Gb/s.</td><td></td></tr><tr><td>2h</td><td></td><td>5 Gb/s.</td><td></td></tr><tr><td>Fh-3h</td><td></td><td>Reserved</td><td></td></tr></table>                                                                                 |                    |                           |  | <u>Bits</u> |                   | <u>Description</u> |                   | 0h  |           | Reserved |                   | 1h  |                    | 2.5 Gb/s. |                           | 2h |  | 5 Gb/s. |  | Fh-3h |  | Reserved |  |
| <u>Bits</u> |                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <u>Description</u> |                           |  |             |                   |                    |                   |     |           |          |                   |     |                    |           |                           |    |  |         |  |       |  |          |  |
| 0h          |                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Reserved           |                           |  |             |                   |                    |                   |     |           |          |                   |     |                    |           |                           |    |  |         |  |       |  |          |  |
| 1h          |                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 2.5 Gb/s.          |                           |  |             |                   |                    |                   |     |           |          |                   |     |                    |           |                           |    |  |         |  |       |  |          |  |
| 2h          |                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 5 Gb/s.            |                           |  |             |                   |                    |                   |     |           |          |                   |     |                    |           |                           |    |  |         |  |       |  |          |  |
| Fh-3h       |                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Reserved           |                           |  |             |                   |                    |                   |     |           |          |                   |     |                    |           |                           |    |  |         |  |       |  |          |  |
| 15:12       | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                            |                    |                           |  |             |                   |                    |                   |     |           |          |                   |     |                    |           |                           |    |  |         |  |       |  |          |  |
| 11          | <b>LinkAutonomousBWIntEn: link autonomous bandwidth interrupt enable.</b> Read-only.                                                                                                                                                                                                                                                                                                                                                                 |                    |                           |  |             |                   |                    |                   |     |           |          |                   |     |                    |           |                           |    |  |         |  |       |  |          |  |
| 10          | <b>LinkBWManagementEn: link bandwidth management interrupt enable.</b> Read-only.                                                                                                                                                                                                                                                                                                                                                                    |                    |                           |  |             |                   |                    |                   |     |           |          |                   |     |                    |           |                           |    |  |         |  |       |  |          |  |
| 9           | <b>HWAutonomousWidthDisable: hardware autonomous width disable.</b> Read-only. 1=Hardware not allowed to change the link width except to correct unreliable link operation by reducing link width.                                                                                                                                                                                                                                                   |                    |                           |  |             |                   |                    |                   |     |           |          |                   |     |                    |           |                           |    |  |         |  |       |  |          |  |
| 8           | <b>ClockPowerManagementEn: clock power management enable.</b> Read-only.                                                                                                                                                                                                                                                                                                                                                                             |                    |                           |  |             |                   |                    |                   |     |           |          |                   |     |                    |           |                           |    |  |         |  |       |  |          |  |
| 7           | <b>ExtendedSync: extended sync.</b> Read-only. 1=Forces the transmission of additional ordered sets when exiting the L0s state and when in the recovery state.                                                                                                                                                                                                                                                                                       |                    |                           |  |             |                   |                    |                   |     |           |          |                   |     |                    |           |                           |    |  |         |  |       |  |          |  |
| 6           | <b>CommonClockCfg: common clock configuration.</b> Read-only. 1=Indicates that the root port and the component at the opposite end of this Link are operating with a distributed common reference clock. 0=Indicates that the upstream port and the component at the opposite end of this Link are operating with asynchronous reference clock.                                                                                                      |                    |                           |  |             |                   |                    |                   |     |           |          |                   |     |                    |           |                           |    |  |         |  |       |  |          |  |
| 5           | <b>RetrainLink: retrain link.</b> Read-only. This bit does not apply to endpoints.                                                                                                                                                                                                                                                                                                                                                                   |                    |                           |  |             |                   |                    |                   |     |           |          |                   |     |                    |           |                           |    |  |         |  |       |  |          |  |
| 4           | <b>LinkDis: link disable.</b> Read-only. This bit does not apply to endpoints.                                                                                                                                                                                                                                                                                                                                                                       |                    |                           |  |             |                   |                    |                   |     |           |          |                   |     |                    |           |                           |    |  |         |  |       |  |          |  |
| 3           | <b>ReadCplBoundary: read completion boundary.</b> Read-only. 0=64 byte read completion boundary.                                                                                                                                                                                                                                                                                                                                                     |                    |                           |  |             |                   |                    |                   |     |           |          |                   |     |                    |           |                           |    |  |         |  |       |  |          |  |
| 2           | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                            |                    |                           |  |             |                   |                    |                   |     |           |          |                   |     |                    |           |                           |    |  |         |  |       |  |          |  |
| 1:0         | <b>PmControl: active state power management enable.</b> Read-only. This field controls the level of ASPM supported on the given PCI Express link.<br><table><tr><td><u>Bits</u></td><td><u>Definition</u></td><td><u>Bits</u></td><td><u>Definition</u></td></tr><tr><td>00b</td><td>Disabled.</td><td>10b</td><td>L1 Entry Enabled.</td></tr><tr><td>01b</td><td>L0s Entry Enabled.</td><td>11b</td><td>L0s and L1 Entry Enabled.</td></tr></table> |                    |                           |  | <u>Bits</u> | <u>Definition</u> | <u>Bits</u>        | <u>Definition</u> | 00b | Disabled. | 10b      | L1 Entry Enabled. | 01b | L0s Entry Enabled. | 11b       | L0s and L1 Entry Enabled. |    |  |         |  |       |  |          |  |
| <u>Bits</u> | <u>Definition</u>                                                                                                                                                                                                                                                                                                                                                                                                                                    | <u>Bits</u>        | <u>Definition</u>         |  |             |                   |                    |                   |     |           |          |                   |     |                    |           |                           |    |  |         |  |       |  |          |  |
| 00b         | Disabled.                                                                                                                                                                                                                                                                                                                                                                                                                                            | 10b                | L1 Entry Enabled.         |  |             |                   |                    |                   |     |           |          |                   |     |                    |           |                           |    |  |         |  |       |  |          |  |
| 01b         | L0s Entry Enabled.                                                                                                                                                                                                                                                                                                                                                                                                                                   | 11b                | L0s and L1 Entry Enabled. |  |             |                   |                    |                   |     |           |          |                   |     |                    |           |                           |    |  |         |  |       |  |          |  |

## D1F1x7C Device Capability 2

Reset: 0000\_0000h.

| Bits | Description                                                               |
|------|---------------------------------------------------------------------------|
| 31:5 | Reserved.                                                                 |
| 4    | <b>CplTimeoutDisSup: completion timeout disable supported.</b> Read-only. |
| 3:0  | <b>CplTimeoutRangeSup: completion timeout range supported.</b> Read-only. |

## D1F1x80 Device Control and Status 2

Reset: 0000\_0000h.

| Bits | Description                                                            |
|------|------------------------------------------------------------------------|
| 31:5 | Reserved.                                                              |
| 4    | <b>CplTimeoutDis: completion timeout disable.</b> Read-only.           |
| 3:0  | <b>CplTimeoutValue: completion timeout range supported.</b> Read-only. |



**D1F1x84 Link Capability 2**

| Bits | Description |
|------|-------------|
| 31:0 | Reserved.   |

**D1F1x88 Link Control and Status 2**

Reset: 0000\_0000h.

| Bits  | Description                                                                                                                                       |
|-------|---------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:17 | Reserved.                                                                                                                                         |
| 16    | <b>CurDeemphasisLevel: current deemphasis level.</b> Read-only. 1=-3.5 dB. 0=-6 dB.                                                               |
| 15:13 | Reserved.                                                                                                                                         |
| 12    | <b>ComplianceDeemphasis: compliance deemphasis.</b> Read-only. This bit defines the deemphasis level used in compliance mode. 1=-3.5 dB. 0=-6 dB. |
| 11    | <b>ComplianceSOS: compliance SOS.</b> Read-only. 1=The device transmits skip ordered sets in between the modified compliance pattern.             |
| 10    | <b>EnterModCompliance: enter modified compliance.</b> Read-only. 1=The device transmits modified compliance pattern.                              |
| 9:7   | <b>XmitMargin: transmit margin.</b> Read-only. This field controls the non-deemphasized voltage level at the transmitter pins.                    |
| 6     | <b>SelectableDeemphasis: selectable deemphasis.</b> Read-only.                                                                                    |
| 5     | <b>HwAutonomousSpeedDisable: hardware autonomous speed disable.</b> Read-only. 1=Disables hardware generated link speed changes.                  |
| 4     | <b>EnterCompliance: enter compliance.</b> Read-only. 1=Force link to enter compliance mode.                                                       |
| 3:0   | <b>TargetLinkSpeed: target link speed.</b> Read-only. This fields defines the upper limit of the link operational speed.                          |

**D1F1xA0 MSI Capability**

| Bits  | Description                                                                                                                                                                                                                                                                 |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:24 | Reserved.                                                                                                                                                                                                                                                                   |
| 23    | <b>Msi64bit: MSI 64 bit capability.</b> Read-only. Reset: 1. 1=The device is capable of sending 64-bit MSI messages. 0=The device is not capable of sending a 64-bit message address.                                                                                       |
| 22:20 | <b>MsiMultiEn: MSI multiple message enable.</b> Read-write. Reset: 000b. Software writes to this field to indicate the number of allocated vectors (equal to or less than the number of requested vectors). When MSI is enabled, a function is allocated at least 1 vector. |
| 19:17 | <b>MsiMultiCap: MSI multiple message capability.</b> Read-only. Reset:000b. 000b=The device is requesting one vector.                                                                                                                                                       |
| 16    | <b>MsiEn: MSI enable.</b> Read-write. Reset: 0. 1=MSI generation is enabled and INTx generation is disabled. 0=MSI generation disabled and INTx generation is enabled.                                                                                                      |
| 15:8  | <b>NextPtr: next pointer.</b> Read-only. Reset: 00h.                                                                                                                                                                                                                        |
| 7:0   | <b>CapID: capability ID.</b> Read-only. Reset: 05h. 05h=MSI capability structure.                                                                                                                                                                                           |

**D1F1xA4 MSI Message Address Low**

Reset: 0000\_0000h.

| Bits | Description                                                                                                                                   |
|------|-----------------------------------------------------------------------------------------------------------------------------------------------|
| 31:2 | <b>MsiMsgAddrLo: MSI message address.</b> Read-write. This register specifies the dword aligned address for the MSI memory write transaction. |
| 1:0  | Reserved.                                                                                                                                     |

**D1F1xA8 MSI Message Address High**

Reset: 0000\_0000h.

| Bits | Description                                                                                                                           |
|------|---------------------------------------------------------------------------------------------------------------------------------------|
| 31:8 | Reserved.                                                                                                                             |
| 7:0  | <b>MsiMsgAddrHi: MSI message address.</b> Read-write. This register specifies the upper 8-bits of the MSI address in 64 bit MSI mode. |

**D1F1xAC MSI Message Data**

Reset: 0000\_0000h.

| Bits  | Description                                                                                                                                                       |
|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:16 | Reserved.                                                                                                                                                         |
| 15:0  | <b>MsiData: MSI message data.</b> Read-write. This register specifies lower 16 bits of data for the MSI memory write transaction. The upper 16 bits are always 0. |

**D1F1x100 Vendor Specific Enhanced Capability**

Reset: 0111\_000Bh.

| Bits  | Description                                   |
|-------|-----------------------------------------------|
| 31:20 | <b>NextPtr: next pointer.</b> Read-only.      |
| 19:16 | <b>CapVer: capability version.</b> Read-only. |
| 15:0  | <b>CapID: capability ID.</b> Read-only.       |

**D1F1x104 Vendor Specific Header**

Reset: 0101\_0001h.

| Bits  | Description                                                             |
|-------|-------------------------------------------------------------------------|
| 31:20 | <b>VsecLen: vendor specific enhanced next pointer.</b> Read-only.       |
| 19:16 | <b>VsecRev: vendor specific enhanced capability version.</b> Read-only. |
| 15:0  | <b>VsecID: vendor specific enhanced capability ID.</b> Read-only.       |

**D1F1x108 Vendor Specific 1**

---

Reset: 0000\_0000h.

| Bits | Description                          |
|------|--------------------------------------|
| 31:0 | <b>Scratch: scratch.</b> Read-write. |

**D1F1x10C Vendor Specific 2**

---

Reset: 0000\_0000h.

| Bits | Description                          |
|------|--------------------------------------|
| 31:0 | <b>Scratch: scratch.</b> Read-write. |

### 3.7 Device [4:2] Function 0 (Host Bridge) Configuration Registers

See 3.1 [Register Descriptions and Mnemonics] for a description of the register naming convention. See 2.7 [Configuration Space] for details about how to access this space. D[4:2]F0 registers do not control any hardware. They ensure that software can configure functions 1 through 4.

#### D[4:2]F0x00 Device/Vendor ID (Host Bridge)

| Bits  | Description                                          |
|-------|------------------------------------------------------|
| 31:16 | <b>DeviceID:</b> device ID. Read-only. Value: 1424h. |
| 15:0  | <b>VendorID:</b> vendor ID. Read-only. Value: 1022h. |

#### D[4:2]F0x04 Status/Command

Reset: 0000\_0000h.

| Bits  | Description                |
|-------|----------------------------|
| 31:16 | <b>Status.</b> Read-only.  |
| 15:0  | <b>Command.</b> Read-only. |

#### D[4:2]F0x08 Class Code/Revision ID

Reset: 0600\_0000h.

| Bits | Description                                   |
|------|-----------------------------------------------|
| 31:8 | <b>ClassCode:</b> class code. Read-only.      |
| 7:0  | <b>RevId:</b> revision identifier. Read-only. |

#### D[4:2]F0x0C Header Type

Reset: 0080\_0000h.

| Bits  | Description                                                                                                                                                          |
|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:24 | Reserved.                                                                                                                                                            |
| 23    | <b>DeviceType.</b> Read-only. 1=Indicates that the northbridge block is a multi-function device. 0=Indicates that the northbridge block is a single function device. |
| 22:16 | <b>HeaderType.</b> Read-only. Indicates multiple functions present in this device.                                                                                   |
| 15:0  | Reserved.                                                                                                                                                            |

**D[4:2]F0x40 Header Type Write**

Reset: 0080\_0000h.

| Bits | Description                                                                                                                                               |
|------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:8 | Reserved.                                                                                                                                                 |
| 7    | <b>DeviceType</b> . Read-write. This field sets the value in <a href="#">D[4:2]F0x0C[DeviceType]</a> . 0=Single function device. 1=Multi-function device. |
| 6:0  | Reserved.                                                                                                                                                 |

**3.8 Device [4:2] Function [5:1] (Root Port) Configuration Registers**

See [3.1 \[Register Descriptions and Mnemonics\]](#) for a description of the register naming convention. See [2.7 \[Configuration Space\]](#) for details about how to access this space. See [2.11.1 \[Overview\]](#).

**D[4:2]F[5:1]x00 Device/Vendor ID**Table 110: [Register Mapping](#) for [D\[4:2\]F\[5:1\]x00](#)

| <a href="#">D[4:2]F[5:1]x00</a> | Function      |
|---------------------------------|---------------|
| D2F1x00                         | Gfx Bridge 0  |
| D2F2x00                         | Gfx Bridge 1  |
| D3F1x00                         | GPP Bridge 0  |
| D3F2x00                         | GPP Bridge 1  |
| D3F3x00                         | GPP Bridge 2  |
| D3F4x00                         | GPP Bridge 3  |
| D3F5x00                         | GPP Bridge 4  |
| D4F1x00                         | Bridge to FCH |

Table 111: [Reset Mapping](#) for [D\[4:2\]F\[5:1\]x00](#)

| Register | Value      |
|----------|------------|
| D2F1x00  | 1425_1022h |
| D2F2x00  | 1425_1022h |
| D3F1x00  | 1426_1022h |
| D3F2x00  | 1426_1022h |
| D3F3x00  | 1426_1022h |
| D3F4x00  | 1426_1022h |
| D3F5x00  | 1426_1022h |
| D4F1x00  | 1426_1022h |

| Bits  | Description                            |
|-------|----------------------------------------|
| 31:16 | <b>DeviceID: device ID.</b> Read-only. |
| 15:0  | <b>VendorID: vendor ID.</b> Read-only. |

**D[4:2]F[5:1]x04 Status/Command Register**

Reset: 0010\_0000h.

| Bits  | Description                                                                                                                                              |
|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31    | <b>ParityErrorDetected: detected parity error.</b> Read; Write-1-to-clear.                                                                               |
| 30    | <b>SignaledSystemError: signaled system error.</b> Read; Write-1-to-clear. 1=System error signalled.                                                     |
| 29    | <b>ReceivedMasterAbort: received master abort.</b> Read; Write-1-to-clear.                                                                               |
| 28    | <b>ReceivedTargetAbort: received target abort.</b> Read; Write-1-to-clear.                                                                               |
| 27    | <b>SignalTargetAbort: signaled target abort.</b> Read; Write-1-to-clear.                                                                                 |
| 26:25 | <b>DevselTiming: DEVSEL# Timing.</b> Read-only.                                                                                                          |
| 24    | <b>DataPerr: data parity error.</b> Read; Write-1-to-clear.                                                                                              |
| 23    | <b>FastBackCapable: fast back-to-back capable.</b> Read-only.                                                                                            |
| 22    | Reserved.                                                                                                                                                |
| 21    | <b>PCI66En: 66 MHz capable.</b> Read-only.                                                                                                               |
| 20    | <b>CapList: capability list.</b> Read-only. 1= Capability list present.                                                                                  |
| 19    | <b>IntStatus: interrupt status.</b> Read-only. 1=An INTx interrupt Message is pending in the device.                                                     |
| 18:11 | Reserved.                                                                                                                                                |
| 10    | <b>IntDis: interrupt disable.</b> Read-write.                                                                                                            |
| 9     | <b>FastB2BEn: fast back-to-back enable.</b> Read-only.                                                                                                   |
| 8     | <b>SerrEn: system error enable.</b> Read-write. 1=System error reporting enabled.                                                                        |
| 7     | <b>Stepping: Stepping control.</b> Read-only.                                                                                                            |
| 6     | <b>ParityErrorEn: parity error response enable.</b> Read-write.                                                                                          |
| 5     | <b>PalSnoopEn: VGA palette snoop enable.</b> Read-only.                                                                                                  |
| 4     | <b>MemWriteInvalidateEn: memory write and invalidate enable.</b> Read-only.                                                                              |
| 3     | <b>SpecialCycleEn: special cycle enable.</b> Read-only.                                                                                                  |
| 2     | <b>BusMasterEn: bus master enable.</b> Read-write.                                                                                                       |
| 1     | <b>MemAccessEn: IO access enable.</b> Read-write. This bit controls if memory accesses targeting this device are accepted or not. 1=Enabled. 0=Disabled. |
| 0     | <b>IoAccessEn: IO access enable.</b> Read-write. This bit controls if IO accesses targeting this device are accepted or not. 1=Enabled. 0=Disabled.      |

**D[4:2]F[5:1]x08 Class Code/Revision ID Register**

Reset: 0604\_00xxh.

| Bits | Description                                                                                            |
|------|--------------------------------------------------------------------------------------------------------|
| 31:8 | <b>ClassCode</b> . Read-only. Provides the host bridge class code as defined in the PCI specification. |
| 7:0  | <b>RevID: revision ID</b> . Read-only.                                                                 |

**D[4:2]F[5:1]x0C Header Type Register**

Reset: 0001\_0000h.

| Bits  | Description                                                                                                                    |
|-------|--------------------------------------------------------------------------------------------------------------------------------|
| 31:24 | <b>BIST</b> . Read-only. These bits are fixed at their default values.                                                         |
| 23    | <b>DeviceType</b> . Read-only. 0=Single function device. 1=Multi-function device.                                              |
| 22:16 | <b>HeaderType</b> . Read-only. These bits are fixed at their default values. Indicates a Type 0 or Type 1 configuration space. |
| 15:8  | <b>LatencyTimer</b> . Read-only. This field does not control any hardware.                                                     |
| 7:0   | <b>CacheLineSize</b> . Read-write.                                                                                             |

**D[4:2]F[5:1]x18 Bus Number and Secondary Latency Register**

Reset: 0000\_0000h.

| Bits  | Description                                                                                                                                         |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:24 | <b>SecondaryLatencyTimer: secondary latency timer</b> . Read-only. This field is always 0.                                                          |
| 23:16 | <b>SubBusNumber: subordinate number</b> . Read-write. This field contains the highest-numbered bus that exists on the secondary side of the bridge. |
| 15:8  | <b>SecondaryBus: secondary bus number</b> . Read-write. This field defines the bus number of the secondary bus interface.                           |
| 7:0   | <b>PrimaryBus: primary bus number</b> . Read-write. This field defines the bus number of the primary bus interface.                                 |

**D[4:2]F[5:1]x1C IO Base and Secondary Status Register**

Reset: 0000\_0101h.

| Bits | Description                                                                                                                                                            |
|------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31   | <b>ParityErrorDetected: detected parity error</b> . Read; Write-1-to-clear. A Poisoned TLP was received regardless of the state of the D[4:2]F[5:1]x04[ParityErrorEn]. |
| 30   | <b>ReceivedSystemError: signaled system error</b> . Read; Write-1-to-clear. 1=A System Error was detected.                                                             |
| 29   | <b>ReceivedMasterAbort: received master abort</b> . Read; Write-1-to-clear. 1=A CPU transaction is terminated due to a master-abort.                                   |
| 28   | <b>ReceivedTargetAbort: received target abort</b> . Read; Write-1-to-clear. 1=A CPU transaction (except for a special cycle) is terminated due to a target-abort.      |

|       |                                                                                                                                                                                 |
|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 27    | <b>SignalTargetAbort:</b> signaled target abort. Read; Write-1-to-clear.                                                                                                        |
| 26:25 | <b>DevselTiming:</b> DEVSEL# Timing. Read-only.                                                                                                                                 |
| 24    | <b>MasterDataPerr:</b> master data parity error. Read; Write-1-to-clear. 1=The link received a poisoned or poisoned a downstream write and D[4:2]F[5:1]x3C[ParityResponseEn]=1. |
| 23    | <b>FastBackCapable:</b> fast back-to-back capable. Read-only.                                                                                                                   |
| 22    | Reserved.                                                                                                                                                                       |
| 21    | <b>PCI66En:</b> 66 MHz capable. Read-only.                                                                                                                                      |
| 20    | <b>CapList:</b> capability list. Read-only.                                                                                                                                     |
| 19:16 | Reserved.                                                                                                                                                                       |
| 15:12 | <b>IOLimit[15:12].</b> Read-write. Lower part of the limit address. Upper part is defined in D[4:2]F[5:1]x30.                                                                   |
| 11:8  | <b>IOLimitType.</b> Read-only. 0=16-bit. 1=32-bit.                                                                                                                              |
| 7:4   | <b>IOBase[15:12].</b> Read-write. Lower part of the base address. Upper part is defined in D[4:2]F[5:1]x30.                                                                     |
| 3:0   | <b>IOBaseType.</b> Read-only. 0=16-bit. 1=32-bit.                                                                                                                               |

#### D[4:2]F[5:1]x20 Memory Limit and Base Register

Reset: 0000\_0000h.

| Bits  | Description                                         |
|-------|-----------------------------------------------------|
| 31:20 | <b>MemLimit[31:20].</b> Read-write.                 |
| 19:16 | <b>MemLimitType.</b> Read-only. 0=32-bit. 1=64-bit. |
| 15:4  | <b>MemBase[31:20].</b> Read-write.                  |
| 3:0   | <b>MemBaseType.</b> Read-only. 0=32-bit. 1=64-bit.  |

#### D[4:2]F[5:1]x24 Prefetchable Memory Limit and Base Register

Reset: 0001\_0001h.

| Bits  | Description                                                                                                      |
|-------|------------------------------------------------------------------------------------------------------------------|
| 31:20 | <b>PrefMemLimit.</b> Read-write. Lower part of the limit address. Upper part is defined in D[4:2]F[5:1]x2C.      |
| 19:16 | <b>PrefMemLimitType.</b> Read-only. 0=32-bit. 1=64-bit.                                                          |
| 15:4  | <b>PrefMemBase[31:20].</b> Read-write. Lower part of the base address. Upper part is defined in D[4:2]F[5:1]x28. |
| 3:0   | <b>PrefMemBaseType.</b> Read-only. 0=32-bit. 1=64-bit.                                                           |



**D[4:2]F[5:1]x28 Prefetchable Memory Base High Register**

Reset: 0000\_0000h.

| Bits | Description                                                                                                                        |
|------|------------------------------------------------------------------------------------------------------------------------------------|
| 31:0 | <b>PrefMemBase[63:32]</b> . Read-write. Upper part of the base address. Lower part is defined in <a href="#">D[4:2]F[5:1]x24</a> . |

**D[4:2]F[5:1]x2C Prefetchable Memory Limit High Register**

Reset: 0000\_0000h.

| Bits | Description                                                                                                                          |
|------|--------------------------------------------------------------------------------------------------------------------------------------|
| 31:0 | <b>PrefMemLimit[63:32]</b> . Read-write. Upper part of the limit address. Lower part is defined in <a href="#">D[4:2]F[5:1]x24</a> . |

**D[4:2]F[5:1]x30 IO Base and Limit High Register**

Reset: 0000\_0000h.

| Bits  | Description                                                                                                                     |
|-------|---------------------------------------------------------------------------------------------------------------------------------|
| 31:16 | <b>IOLimit[31:16]</b> . Read-write. Upper part of the limit address. Lower part is defined in <a href="#">D[4:2]F[5:1]x1C</a> . |
| 15:0  | <b>IOBase[31:16]</b> . Read-write. Upper part of the base address. Lower part is defined in <a href="#">D[4:2]F[5:1]x1C</a> .   |

**D[4:2]F[5:1]x34 Capabilities Pointer Register**

Reset: 0000\_0050h.

| Bits | Description                                                                |
|------|----------------------------------------------------------------------------|
| 31:8 | Reserved.                                                                  |
| 7:0  | <b>CapPtr: capabilities pointer</b> . Read-only. Pointer to PM capability. |

**D[4:2]F[5:1]x3C Bridge Control Register**

Reset: 0000\_00FFh.

| Bits  | Description                                                                                                                                                          |
|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:24 | Reserved.                                                                                                                                                            |
| 23    | <b>FastB2BCap: Fast back-to-back capability</b> . Read-only.                                                                                                         |
| 22    | <b>SecondaryBusReset: Secondary bus reset</b> . Read-write. Setting this bit triggers a hot reset on the corresponding PCI Express Port.                             |
| 21    | <b>MasterAbortMode: Master abort mode</b> . Read-only.                                                                                                               |
| 20    | <b>Vga16En: VGA IO 16 bit decoding enable</b> . Read-write. 1= Address bits 15:10 for VGA IO cycles are decoded. 0=Address bits 15:10 for VGA IO cycles are ignored. |

|       |                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 19    | <b>VgaEn: VGA enable.</b> Read-write. Affects the response by the bridge to compatible VGA addresses. When it is set, the bridge decodes and forwards the following accesses on the primary interface to the secondary interface:<br>Memory accesses in the range of A_0000h to B_FFFFh and<br>IO address where address bits 9:0 are in the ranges of 3B0h to 3BBh or 3C0h to 3DFh. For IO cycles the decoding of address bits 15:10 depends on Vga16En. |
| 18    | <b>IsaEn: ISA enable.</b> Read-write.                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 17    | <b>SerrEn: SERR enable.</b> Read-write.                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 16    | <b>ParityResponseEn: Parity response enable.</b> Read-write. Controls the bridge's response to poisoned TLPs on its secondary interface. 1=The bridge takes its normal action when a poisoned TLP is received. 0=The bridge ignores any poisoned TLPs that it receives and continues normal operation.                                                                                                                                                   |
| 15:11 | <b>IntPinR: interrupt pin.</b> Read-only.                                                                                                                                                                                                                                                                                                                                                                                                                |
| 10:8  | <b>IntPin: interrupt pin.</b> IF (D0F0xE4_x0140_0010[HwInitWrLock]==1) THEN Read-only. ELSE Read-write. ENDIF.                                                                                                                                                                                                                                                                                                                                           |
| 7:0   | <b>IntLine: Interrupt line.</b> Read-write.                                                                                                                                                                                                                                                                                                                                                                                                              |

#### D[4:2]F[5:1]x50 Power Management Capability Register

Reset: 0003\_5801h.

| Bits  | Description                                                                                                                                                            |
|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:27 | <b>PmeSupport.</b> Read-only.                                                                                                                                          |
| 26    | <b>D2Support: D2 support.</b> Read-only. D2 is not supported                                                                                                           |
| 25    | <b>D1Support: D1 support.</b> Read-only. D1 is not supported                                                                                                           |
| 24:22 | <b>AuxCurrent: auxiliary current.</b> Read-only. Auxiliary current is not supported.                                                                                   |
| 21    | <b>DevSpecificInit: device specific initialization.</b> Read-only. This field is hardwired to 0 to indicate that there is no device specific initialization necessary. |
| 20    | Reserved.                                                                                                                                                              |
| 19    | <b>PmeClock.</b> Read-only. 0=Indicate that PCI clock is not needed to generate PME messages.                                                                          |
| 18:16 | <b>Version: version.</b> Read-only. 3=PMI Spec 1.2                                                                                                                     |
| 15:8  | <b>NextPtr: next pointer.</b> Read-only. 58h=Address of the next capability structure.                                                                                 |
| 7:0   | <b>CapID: capability ID.</b> Read-only. 01h=PCI power management data structure.                                                                                       |

#### D[4:2]F[5:1]x54 Power Management Control and Status Register

| Bits  | Description                                                                                                                                                                                                                                                                                |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:24 | <b>PmiData.</b> Read-only. Reset: 0.                                                                                                                                                                                                                                                       |
| 23    | <b>BusPwrEn.</b> Read-only. Reset: 0.                                                                                                                                                                                                                                                      |
| 22    | <b>B2B3Support.</b> Read-only. Reset: 0. B states are not supported.                                                                                                                                                                                                                       |
| 21:16 | Reserved.                                                                                                                                                                                                                                                                                  |
| 15    | <b>PmeStatus: PME status.</b> Read; Write-1-to-clear. Reset: 0. This bit is set when the root port would issue a PME message (independent of the state of the PmeEn bit). Once set, this bit remains set until it is reset by writing a 1 to this bit location. Writing a 0 has no effect. |

|             |                                                                                                                                                                                                                                                                                                                                                                                                                                           |             |                   |             |                   |     |    |     |          |     |          |     |    |
|-------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|-------------------|-------------|-------------------|-----|----|-----|----------|-----|----------|-----|----|
| 14:13       | <b>DataScale: data scale.</b> Read-only. Reset: 0.                                                                                                                                                                                                                                                                                                                                                                                        |             |                   |             |                   |     |    |     |          |     |          |     |    |
| 12:9        | <b>DataSelect: data select.</b> Read-only. Reset: 0.                                                                                                                                                                                                                                                                                                                                                                                      |             |                   |             |                   |     |    |     |          |     |          |     |    |
| 8           | <b>PmeEn: PME# enable.</b> Read-write. Reset: 0.                                                                                                                                                                                                                                                                                                                                                                                          |             |                   |             |                   |     |    |     |          |     |          |     |    |
| 7:4         | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                 |             |                   |             |                   |     |    |     |          |     |          |     |    |
| 3           | <b>NoSoftReset: no soft reset.</b> Read-only. Reset: 0. Software is required to re-initialize the function when returning from D3 <sub>hot</sub> .                                                                                                                                                                                                                                                                                        |             |                   |             |                   |     |    |     |          |     |          |     |    |
| 2           | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                 |             |                   |             |                   |     |    |     |          |     |          |     |    |
| 1:0         | <b>PowerState: power state.</b> Read-write. Reset: 0. This 2-bit field is used both to determine the current power state of the root port and to set the root port into a new power state. <table><tr><td><u>Bits</u></td><td><u>Definition</u></td><td><u>Bits</u></td><td><u>Definition</u></td></tr><tr><td>00b</td><td>D0</td><td>10b</td><td>Reserved</td></tr><tr><td>01b</td><td>Reserved</td><td>11b</td><td>D3</td></tr></table> | <u>Bits</u> | <u>Definition</u> | <u>Bits</u> | <u>Definition</u> | 00b | D0 | 10b | Reserved | 01b | Reserved | 11b | D3 |
| <u>Bits</u> | <u>Definition</u>                                                                                                                                                                                                                                                                                                                                                                                                                         | <u>Bits</u> | <u>Definition</u> |             |                   |     |    |     |          |     |          |     |    |
| 00b         | D0                                                                                                                                                                                                                                                                                                                                                                                                                                        | 10b         | Reserved          |             |                   |     |    |     |          |     |          |     |    |
| 01b         | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                  | 11b         | D3                |             |                   |     |    |     |          |     |          |     |    |

### D[4:2]F[5:1]x58 PCI Express Capability Register

Reset: 0042\_A010h.

| Bits  | Description                                                                                                                            |
|-------|----------------------------------------------------------------------------------------------------------------------------------------|
| 31:30 | Reserved.                                                                                                                              |
| 29:25 | <b>IntMessageNum: interrupt message number.</b> Read-only. This register indicates which MSI vector is used for the interrupt message. |
| 24    | <b>SlotImplemented: slot implemented.</b> Read-only. 1=The IO Link associated with this port is connected to a slot.                   |
| 23:20 | <b>DeviceType: device type.</b> Read-only. 4h=Root complex.                                                                            |
| 19:16 | <b>Version.</b> Read-only. 2h=GEN 2 compliant.                                                                                         |
| 15:8  | <b>NextPtr: next pointer.</b> Read-only. A0h=Pointer to the next capability structure.                                                 |
| 7:0   | <b>CapID: capability ID.</b> Read-only. 10h=PCIe <sup>®</sup> Capability structure.                                                    |

### D[4:2]F[5:1]x5C Device Capability Register

Reset: 0000\_0020h.

| Bits  | Description                                                                |
|-------|----------------------------------------------------------------------------|
| 31:29 | Reserved.                                                                  |
| 28    | <b>FlrCapable: function level reset capability.</b> Read-only.             |
| 27:26 | <b>CapturedSlotPowerScale: captured slot power limit scale.</b> Read-only. |
| 25:18 | <b>CapturedSlotPowerLimit: captured slot power limit value.</b> Read-only. |
| 17:16 | Reserved.                                                                  |
| 15    | <b>RoleBasedErrReporting: role-based error reporting.</b> Read-only.       |
| 14:12 | Reserved.                                                                  |
| 11:9  | <b>L1AcceptableLatency: endpoint L1 Acceptable Latency.</b> Read-only.     |
| 8:6   | <b>L0SAcceptableLatency: endpoint L0s Acceptable Latency.</b> Read-only.   |

|     |                                                                                                           |
|-----|-----------------------------------------------------------------------------------------------------------|
| 5   | <b>ExtendedTag: extended tag support.</b> Read-only.<br>1: 8 bit tag supported<br>0: 5 bit tag supported. |
| 4:3 | <b>PhantomFunc: phantom function support.</b> Read-only. 0=No phantom functions supported.                |
| 2:0 | <b>MaxPayloadSupport: maximum supported payload size.</b> Read-only. 000b=128 bytes max payload size.     |

### D[4:2]F[5:1]x60 Device Control and Status Register

Reset: 0000\_2810h.

| Bits  | Description                                                                                                                                                                                                                                                                                                                               |      |            |      |            |    |      |    |       |    |      |    |       |    |      |    |       |
|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------------|------|------------|----|------|----|-------|----|------|----|-------|----|------|----|-------|
| 31:22 | Reserved.                                                                                                                                                                                                                                                                                                                                 |      |            |      |            |    |      |    |       |    |      |    |       |    |      |    |       |
| 21    | <b>TransactionsPending: transactions pending.</b> Read-only. 0=No internally generated non-posted transactions pending.                                                                                                                                                                                                                   |      |            |      |            |    |      |    |       |    |      |    |       |    |      |    |       |
| 20    | <b>AuxPwr: auxiliary power.</b> Read-only.                                                                                                                                                                                                                                                                                                |      |            |      |            |    |      |    |       |    |      |    |       |    |      |    |       |
| 19    | <b>UsrDetected: unsupported request detected.</b> Read; Write-1-to-clear. 1=The port received an unsupported request. Errors are logged in this register even if error reporting is disabled.                                                                                                                                             |      |            |      |            |    |      |    |       |    |      |    |       |    |      |    |       |
| 18    | <b>FatalErr: fatal error detected.</b> Read; Write-1-to-clear. 1=The port detected a fatal error. Errors are logged in this register even if error reporting is disabled.                                                                                                                                                                 |      |            |      |            |    |      |    |       |    |      |    |       |    |      |    |       |
| 17    | <b>NonFatalErr: non-fatal error detected.</b> Read; Write-1-to-clear. T1=The port detected a non-fatal error. Errors are logged in this register even if error reporting is disabled.                                                                                                                                                     |      |            |      |            |    |      |    |       |    |      |    |       |    |      |    |       |
| 16    | <b>CorrErr: correctable error detected.</b> Read; Write-1-to-clear. 1=The port detected a correctable error. Errors are logged in this register even if error reporting is disabled.                                                                                                                                                      |      |            |      |            |    |      |    |       |    |      |    |       |    |      |    |       |
| 15    | <b>BridgeCfgRetryEn: bridge configuration retry enable.</b> Read-only.                                                                                                                                                                                                                                                                    |      |            |      |            |    |      |    |       |    |      |    |       |    |      |    |       |
| 14:12 | <b>MaxRequestSize: maximum request size.</b> Read-write.                                                                                                                                                                                                                                                                                  |      |            |      |            |    |      |    |       |    |      |    |       |    |      |    |       |
| 11    | <b>NoSnoopEnable: enable no snoop.</b> Read-write. 1=The port is permitted to set the No Snoop bit in the Requester Attributes of transactions it initiates that do not require hardware enforced cache coherency.                                                                                                                        |      |            |      |            |    |      |    |       |    |      |    |       |    |      |    |       |
| 10    | <b>AuxPowerPmEn: auxiliary power PM enable.</b> Read-only.                                                                                                                                                                                                                                                                                |      |            |      |            |    |      |    |       |    |      |    |       |    |      |    |       |
| 9     | <b>PhantomFuncEn: phantom functions enable.</b> Read-only.                                                                                                                                                                                                                                                                                |      |            |      |            |    |      |    |       |    |      |    |       |    |      |    |       |
| 8     | <b>ExtendedTagEn: extended tag enable.</b> Read-write. 1=8-bit tags generation enabled. 0=5-bit tags are used.                                                                                                                                                                                                                            |      |            |      |            |    |      |    |       |    |      |    |       |    |      |    |       |
| 7:5   | <b>MaxPayloadSize: maximum supported payload size.</b> Read-write. <table><tr><th>Bits</th><th>Definition</th><th>Bits</th><th>Definition</th></tr><tr><td>0h</td><td>128B</td><td>3h</td><td>1024B</td></tr><tr><td>1h</td><td>256B</td><td>4h</td><td>2048B</td></tr><tr><td>2h</td><td>512B</td><td>5h</td><td>4096B</td></tr></table> | Bits | Definition | Bits | Definition | 0h | 128B | 3h | 1024B | 1h | 256B | 4h | 2048B | 2h | 512B | 5h | 4096B |
| Bits  | Definition                                                                                                                                                                                                                                                                                                                                | Bits | Definition |      |            |    |      |    |       |    |      |    |       |    |      |    |       |
| 0h    | 128B                                                                                                                                                                                                                                                                                                                                      | 3h   | 1024B      |      |            |    |      |    |       |    |      |    |       |    |      |    |       |
| 1h    | 256B                                                                                                                                                                                                                                                                                                                                      | 4h   | 2048B      |      |            |    |      |    |       |    |      |    |       |    |      |    |       |
| 2h    | 512B                                                                                                                                                                                                                                                                                                                                      | 5h   | 4096B      |      |            |    |      |    |       |    |      |    |       |    |      |    |       |
| 4     | <b>RelaxedOrdEn: relaxed ordering enable.</b> Read-write. 1=The root port is permitted to set the relaxed ordering bit in the attributes field of transactions it initiates that do not require strong write ordering.                                                                                                                    |      |            |      |            |    |      |    |       |    |      |    |       |    |      |    |       |
| 3     | <b>UsrReportEn: unsupported request reporting enable.</b> Read-write. 1=Reporting of unsupported requests enabled.                                                                                                                                                                                                                        |      |            |      |            |    |      |    |       |    |      |    |       |    |      |    |       |
| 2     | <b>FatalErrEn: fatal error reporting enable.</b> Read-write. 1=Enable sending ERR_FATAL messages.                                                                                                                                                                                                                                         |      |            |      |            |    |      |    |       |    |      |    |       |    |      |    |       |

|   |                                                                                                             |
|---|-------------------------------------------------------------------------------------------------------------|
| 1 | <b>NonFatalErrEn: non-fatal error reporting enable.</b> Read-write. 1=Enable sending ERR_NONFATAL messages. |
| 0 | <b>CorrErrEn: correctable error reporting enable.</b> Read-write. 1=Enable sending ERR_CORR messages.       |

#### D[4:2]F[5:1]x64 IO Link Capability Register

Read-only.

| Bits  | Description                                                                                                                                                     |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:24 | <b>PortNumber: port number.</b> Reset: 0. This field indicates the port number for the given IO link.                                                           |
| 23    | Reserved.                                                                                                                                                       |
| 22    | <b>AspmOptionalityCompliance.</b> Reset: 1. This field indicates if the component supports the ASPM Optionality ECN.                                            |
| 21    | <b>LinkBWNotificationCap: link bandwidth notification capability.</b> Reset: 0.                                                                                 |
| 20    | <b>DIActiveReportingCapable: data link layer active reporting capability.</b> Reset: 0.                                                                         |
| 19    | <b>SurpriseDownErrReporting.</b> Reset: 0. 1=This field indicates if the component supports the detecting and reporting of a Surprise Down error condition.     |
| 18    | <b>ClockPowerManagement: clock power management.</b> Reset: 0. 0=Indicates that the reference clock must not be removed while in L1 or L2/L3 ready link states. |
| 17:15 | <b>L1ExitLatency: L1 exit latency.</b> Reset: 010b. 010b=Indicate an exit latency between 2 us and 4 us.                                                        |
| 14:12 | <b>L0sExitLatency: L0s exit latency.</b> Reset: 001b. 001b=Indicates an exit latency between 64 ns and 128 ns.                                                  |
| 11:10 | <b>PMSupport: active state power management support.</b> Reset: 11b. 11b=Indicates support of L0s and L1.                                                       |

| 9:4     | <b>LinkWidth: maximum link width.</b> Value: 10h.<br><table> <tr> <th>Bits</th><th>Definition</th></tr> <tr><td>00h</td><td>Reserved.</td></tr> <tr><td>01h</td><td>1 lanes</td></tr> <tr><td>02h</td><td>2 lanes</td></tr> <tr><td>03h</td><td>Reserved.</td></tr> <tr><td>04h</td><td>4 lanes</td></tr> <tr><td>07h-05h</td><td>Reserved.</td></tr> <tr><td>08h</td><td>8 lanes</td></tr> <tr><td>0Bh-09h</td><td>Reserved.</td></tr> <tr><td>0Ch</td><td>12 lanes</td></tr> <tr><td>0Fh-0Dh</td><td>Reserved.</td></tr> <tr><td>10h</td><td>16 lanes</td></tr> <tr><td>1Fh-11h</td><td>Reserved.</td></tr> <tr><td>20h</td><td>32 lanes</td></tr> <tr><td>3Fh-21h</td><td>Reserved.</td></tr> </table>                         | Bits | Definition | 00h | Reserved. | 01h | 1 lanes  | 02h | 2 lanes  | 03h | Reserved. | 04h   | 4 lanes   | 07h-05h | Reserved. | 08h | 8 lanes | 0Bh-09h | Reserved. | 0Ch | 12 lanes | 0Fh-0Dh | Reserved. | 10h | 16 lanes | 1Fh-11h | Reserved. | 20h | 32 lanes | 3Fh-21h | Reserved. |
|---------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------------|-----|-----------|-----|----------|-----|----------|-----|-----------|-------|-----------|---------|-----------|-----|---------|---------|-----------|-----|----------|---------|-----------|-----|----------|---------|-----------|-----|----------|---------|-----------|
| Bits    | Definition                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |      |            |     |           |     |          |     |          |     |           |       |           |         |           |     |         |         |           |     |          |         |           |     |          |         |           |     |          |         |           |
| 00h     | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |      |            |     |           |     |          |     |          |     |           |       |           |         |           |     |         |         |           |     |          |         |           |     |          |         |           |     |          |         |           |
| 01h     | 1 lanes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |      |            |     |           |     |          |     |          |     |           |       |           |         |           |     |         |         |           |     |          |         |           |     |          |         |           |     |          |         |           |
| 02h     | 2 lanes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |      |            |     |           |     |          |     |          |     |           |       |           |         |           |     |         |         |           |     |          |         |           |     |          |         |           |     |          |         |           |
| 03h     | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |      |            |     |           |     |          |     |          |     |           |       |           |         |           |     |         |         |           |     |          |         |           |     |          |         |           |     |          |         |           |
| 04h     | 4 lanes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |      |            |     |           |     |          |     |          |     |           |       |           |         |           |     |         |         |           |     |          |         |           |     |          |         |           |     |          |         |           |
| 07h-05h | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |      |            |     |           |     |          |     |          |     |           |       |           |         |           |     |         |         |           |     |          |         |           |     |          |         |           |     |          |         |           |
| 08h     | 8 lanes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |      |            |     |           |     |          |     |          |     |           |       |           |         |           |     |         |         |           |     |          |         |           |     |          |         |           |     |          |         |           |
| 0Bh-09h | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |      |            |     |           |     |          |     |          |     |           |       |           |         |           |     |         |         |           |     |          |         |           |     |          |         |           |     |          |         |           |
| 0Ch     | 12 lanes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |      |            |     |           |     |          |     |          |     |           |       |           |         |           |     |         |         |           |     |          |         |           |     |          |         |           |     |          |         |           |
| 0Fh-0Dh | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |      |            |     |           |     |          |     |          |     |           |       |           |         |           |     |         |         |           |     |          |         |           |     |          |         |           |     |          |         |           |
| 10h     | 16 lanes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |      |            |     |           |     |          |     |          |     |           |       |           |         |           |     |         |         |           |     |          |         |           |     |          |         |           |     |          |         |           |
| 1Fh-11h | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |      |            |     |           |     |          |     |          |     |           |       |           |         |           |     |         |         |           |     |          |         |           |     |          |         |           |     |          |         |           |
| 20h     | 32 lanes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |      |            |     |           |     |          |     |          |     |           |       |           |         |           |     |         |         |           |     |          |         |           |     |          |         |           |     |          |         |           |
| 3Fh-21h | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |      |            |     |           |     |          |     |          |     |           |       |           |         |           |     |         |         |           |     |          |         |           |     |          |         |           |     |          |         |           |
| 3:0     | <b>LinkSpeed: link speed.</b> Value:<br>IF (D[4:2]F[5:1]xE4_xA4[LcGen2EnStrap]==0 &&<br>D[4:2]F[5:1]xE4_xA4[LcGen3EnStrap]==0) THEN 1h<br>ELSEIF (D[4:2]F[5:1]xE4_xA4[LcGen2EnStrap]==1 &&<br>D[4:2]F[5:1]xE4_xA4[LcGen3EnStrap]==0) THEN 2h<br>ELSEIF (D[4:2]F[5:1]xE4_xA4[LcGen2EnStrap]==0 &&<br>D[4:2]F[5:1]xE4_xA4[LcGen3EnStrap]==1) THEN 3h<br>ELSEIF (D[4:2]F[5:1]xE4_xA4[LcGen2EnStrap]==1 &&<br>D[4:2]F[5:1]xE4_xA4[LcGen3EnStrap]==1) THEN 3h ENDIF.<br><table> <tr> <th>Bits</th><th>Definition</th></tr> <tr><td>0h</td><td>Reserved.</td></tr> <tr><td>1h</td><td>2.5 Gb/s</td></tr> <tr><td>2h</td><td>5.0 Gb/s</td></tr> <tr><td>3h</td><td>8.0 Gb/s</td></tr> <tr><td>Fh-4h</td><td>Reserved.</td></tr> </table> | Bits | Definition | 0h  | Reserved. | 1h  | 2.5 Gb/s | 2h  | 5.0 Gb/s | 3h  | 8.0 Gb/s  | Fh-4h | Reserved. |         |           |     |         |         |           |     |          |         |           |     |          |         |           |     |          |         |           |
| Bits    | Definition                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |      |            |     |           |     |          |     |          |     |           |       |           |         |           |     |         |         |           |     |          |         |           |     |          |         |           |     |          |         |           |
| 0h      | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |      |            |     |           |     |          |     |          |     |           |       |           |         |           |     |         |         |           |     |          |         |           |     |          |         |           |     |          |         |           |
| 1h      | 2.5 Gb/s                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |      |            |     |           |     |          |     |          |     |           |       |           |         |           |     |         |         |           |     |          |         |           |     |          |         |           |     |          |         |           |
| 2h      | 5.0 Gb/s                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |      |            |     |           |     |          |     |          |     |           |       |           |         |           |     |         |         |           |     |          |         |           |     |          |         |           |     |          |         |           |
| 3h      | 8.0 Gb/s                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |      |            |     |           |     |          |     |          |     |           |       |           |         |           |     |         |         |           |     |          |         |           |     |          |         |           |     |          |         |           |
| Fh-4h   | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |      |            |     |           |     |          |     |          |     |           |       |           |         |           |     |         |         |           |     |          |         |           |     |          |         |           |     |          |         |           |

### D[4:2]F[5:1]x68 IO Link Control and Status Register

Reset: 1001\_0000h.

| Bits | Description                                                                                                                                                                                               |
|------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31   | <b>LinkAutonomousBWStatus: link autonomous bandwidth status.</b> IF (D[4:2]F[5:1]x64[Link-BWNotificationCap]==0) THEN Read-only. ELSE Read-write; updated-by-hardware. ENDIF.                             |
| 30   | <b>LinkBWManagementStatus: link bandwidth management status.</b> IF (D[4:2]F[5:1]x64[Link-BWNotificationCap]==0) THEN Read-only. ELSE Read-write; updated-by-hardware. ENDIF.                             |
| 29   | <b>DLActive: data link layer link active.</b> Read-only; updated-by-hardware. This bit indicates the status of the data link control and management state machine. 1=DL_Active state. 0=All other states. |
| 28   | <b>SlotClockCfg: slot clock configuration.</b> Read-only; updated-by-hardware. 1=The root port uses the same clock that the platform provides.                                                            |

| 27          | <b>LinkTraining: link training.</b> Read-only; updated-by-hardware. This read-only bit indicates that the physical layer link training state machine is in the configuration or recovery state, or that 1b was written to the RetrainLink bit but link training has not yet begun. Hardware clears this bit when the link training state machine exits the configuration/recovery state.                                                                                                                                                                                                                                                                                                                                                                                                                                                            |             |                   |     |           |     |          |     |          |     |           |       |           |         |           |     |         |         |           |     |          |         |           |     |          |         |           |     |          |         |           |
|-------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|-------------------|-----|-----------|-----|----------|-----|----------|-----|-----------|-------|-----------|---------|-----------|-----|---------|---------|-----------|-----|----------|---------|-----------|-----|----------|---------|-----------|-----|----------|---------|-----------|
| 26          | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |             |                   |     |           |     |          |     |          |     |           |       |           |         |           |     |         |         |           |     |          |         |           |     |          |         |           |     |          |         |           |
| 25:20       | <p><b>NegotiatedLinkWidth: negotiated link width.</b> Read-only; updated-by-hardware. This field indicates the negotiated width of the given PCI Express link.</p> <table> <tr> <th><u>Bits</u></th><th><u>Definition</u></th></tr> <tr> <td>00h</td><td>Reserved.</td></tr> <tr> <td>01h</td><td>1 lanes</td></tr> <tr> <td>02h</td><td>2 lanes</td></tr> <tr> <td>03h</td><td>Reserved.</td></tr> <tr> <td>04h</td><td>4 lanes</td></tr> <tr> <td>07h-05h</td><td>Reserved.</td></tr> <tr> <td>08h</td><td>8 lanes</td></tr> <tr> <td>0Bh-09h</td><td>Reserved.</td></tr> <tr> <td>0Ch</td><td>12 lanes</td></tr> <tr> <td>0Fh-0Dh</td><td>Reserved.</td></tr> <tr> <td>10h</td><td>16 lanes</td></tr> <tr> <td>1Fh-11h</td><td>Reserved.</td></tr> <tr> <td>20h</td><td>32 lanes</td></tr> <tr> <td>3Fh-21h</td><td>Reserved.</td></tr> </table> | <u>Bits</u> | <u>Definition</u> | 00h | Reserved. | 01h | 1 lanes  | 02h | 2 lanes  | 03h | Reserved. | 04h   | 4 lanes   | 07h-05h | Reserved. | 08h | 8 lanes | 0Bh-09h | Reserved. | 0Ch | 12 lanes | 0Fh-0Dh | Reserved. | 10h | 16 lanes | 1Fh-11h | Reserved. | 20h | 32 lanes | 3Fh-21h | Reserved. |
| <u>Bits</u> | <u>Definition</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |             |                   |     |           |     |          |     |          |     |           |       |           |         |           |     |         |         |           |     |          |         |           |     |          |         |           |     |          |         |           |
| 00h         | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |             |                   |     |           |     |          |     |          |     |           |       |           |         |           |     |         |         |           |     |          |         |           |     |          |         |           |     |          |         |           |
| 01h         | 1 lanes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |             |                   |     |           |     |          |     |          |     |           |       |           |         |           |     |         |         |           |     |          |         |           |     |          |         |           |     |          |         |           |
| 02h         | 2 lanes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |             |                   |     |           |     |          |     |          |     |           |       |           |         |           |     |         |         |           |     |          |         |           |     |          |         |           |     |          |         |           |
| 03h         | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |             |                   |     |           |     |          |     |          |     |           |       |           |         |           |     |         |         |           |     |          |         |           |     |          |         |           |     |          |         |           |
| 04h         | 4 lanes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |             |                   |     |           |     |          |     |          |     |           |       |           |         |           |     |         |         |           |     |          |         |           |     |          |         |           |     |          |         |           |
| 07h-05h     | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |             |                   |     |           |     |          |     |          |     |           |       |           |         |           |     |         |         |           |     |          |         |           |     |          |         |           |     |          |         |           |
| 08h         | 8 lanes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |             |                   |     |           |     |          |     |          |     |           |       |           |         |           |     |         |         |           |     |          |         |           |     |          |         |           |     |          |         |           |
| 0Bh-09h     | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |             |                   |     |           |     |          |     |          |     |           |       |           |         |           |     |         |         |           |     |          |         |           |     |          |         |           |     |          |         |           |
| 0Ch         | 12 lanes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |             |                   |     |           |     |          |     |          |     |           |       |           |         |           |     |         |         |           |     |          |         |           |     |          |         |           |     |          |         |           |
| 0Fh-0Dh     | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |             |                   |     |           |     |          |     |          |     |           |       |           |         |           |     |         |         |           |     |          |         |           |     |          |         |           |     |          |         |           |
| 10h         | 16 lanes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |             |                   |     |           |     |          |     |          |     |           |       |           |         |           |     |         |         |           |     |          |         |           |     |          |         |           |     |          |         |           |
| 1Fh-11h     | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |             |                   |     |           |     |          |     |          |     |           |       |           |         |           |     |         |         |           |     |          |         |           |     |          |         |           |     |          |         |           |
| 20h         | 32 lanes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |             |                   |     |           |     |          |     |          |     |           |       |           |         |           |     |         |         |           |     |          |         |           |     |          |         |           |     |          |         |           |
| 3Fh-21h     | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |             |                   |     |           |     |          |     |          |     |           |       |           |         |           |     |         |         |           |     |          |         |           |     |          |         |           |     |          |         |           |
| 19:16       | <p><b>LinkSpeed: link speed.</b> Read-only; updated-by-hardware.</p> <table> <tr> <th><u>Bits</u></th><th><u>Definition</u></th></tr> <tr> <td>00h</td><td>Reserved.</td></tr> <tr> <td>01h</td><td>2.5 Gb/s</td></tr> <tr> <td>02h</td><td>5.0 Gb/s</td></tr> <tr> <td>03h</td><td>8.0 Gb/s</td></tr> <tr> <td>Fh-4h</td><td>Reserved.</td></tr> </table>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <u>Bits</u> | <u>Definition</u> | 00h | Reserved. | 01h | 2.5 Gb/s | 02h | 5.0 Gb/s | 03h | 8.0 Gb/s  | Fh-4h | Reserved. |         |           |     |         |         |           |     |          |         |           |     |          |         |           |     |          |         |           |
| <u>Bits</u> | <u>Definition</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |             |                   |     |           |     |          |     |          |     |           |       |           |         |           |     |         |         |           |     |          |         |           |     |          |         |           |     |          |         |           |
| 00h         | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |             |                   |     |           |     |          |     |          |     |           |       |           |         |           |     |         |         |           |     |          |         |           |     |          |         |           |     |          |         |           |
| 01h         | 2.5 Gb/s                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |             |                   |     |           |     |          |     |          |     |           |       |           |         |           |     |         |         |           |     |          |         |           |     |          |         |           |     |          |         |           |
| 02h         | 5.0 Gb/s                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |             |                   |     |           |     |          |     |          |     |           |       |           |         |           |     |         |         |           |     |          |         |           |     |          |         |           |     |          |         |           |
| 03h         | 8.0 Gb/s                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |             |                   |     |           |     |          |     |          |     |           |       |           |         |           |     |         |         |           |     |          |         |           |     |          |         |           |     |          |         |           |
| Fh-4h       | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |             |                   |     |           |     |          |     |          |     |           |       |           |         |           |     |         |         |           |     |          |         |           |     |          |         |           |     |          |         |           |
| 15:12       | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |             |                   |     |           |     |          |     |          |     |           |       |           |         |           |     |         |         |           |     |          |         |           |     |          |         |           |     |          |         |           |
| 11          | <b>LinkAutonomousBWIntEn: link autonomous bandwidth interrupt enable.</b> Read-write. 1=Enables the generation of an interrupt to indicate that the Link AutonomousBWStatus bit has been set.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |             |                   |     |           |     |          |     |          |     |           |       |           |         |           |     |         |         |           |     |          |         |           |     |          |         |           |     |          |         |           |
| 10          | <b>LinkBWManagementIntEn: link bandwidth management interrupt enable.</b> Read-write. 1=Enables the generation of an interrupt to indicate that the LinkBWManagementStatus has been set.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |             |                   |     |           |     |          |     |          |     |           |       |           |         |           |     |         |         |           |     |          |         |           |     |          |         |           |     |          |         |           |
| 9           | <b>HWAutonomousWidthDisable: hardware autonomous width disable.</b> Read-write. 1=Disables hardware from changing the link width for reasons other than attempting to correct unreliable link operation by reducing link width.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |             |                   |     |           |     |          |     |          |     |           |       |           |         |           |     |         |         |           |     |          |         |           |     |          |         |           |     |          |         |           |
| 8           | <b>ClockPowerManagementEn: clock power management enable.</b> Read-write.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |             |                   |     |           |     |          |     |          |     |           |       |           |         |           |     |         |         |           |     |          |         |           |     |          |         |           |     |          |         |           |
| 7           | <b>ExtendedSync: extended sync.</b> Read-write. 1=Forces the transmission of additional ordered sets when exiting the L0s state and when in the recovery state.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |             |                   |     |           |     |          |     |          |     |           |       |           |         |           |     |         |         |           |     |          |         |           |     |          |         |           |     |          |         |           |
| 6           | <b>CommonClockCfg: common clock configuration.</b> Read-write. 1=Indicates that the root port and the component at the opposite end of this IO link are operating with a distributed common reference clock. 0=Indicates that the root port and the component at the opposite end of this IO Link are operating with asynchronous reference clock.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |             |                   |     |           |     |          |     |          |     |           |       |           |         |           |     |         |         |           |     |          |         |           |     |          |         |           |     |          |         |           |
| 5           | <b>RetrainLink: retrain link.</b> Read-write; cleared-when-done. 1=Initiate link retraining.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |             |                   |     |           |     |          |     |          |     |           |       |           |         |           |     |         |         |           |     |          |         |           |     |          |         |           |     |          |         |           |

|     |                                                                                                                                                                         |                    |             |                           |
|-----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|-------------|---------------------------|
| 4   | <b>LinkDis: link disable.</b> Read-write. 1=Disable link. Writes to this bit are immediately reflected in the value read from the bit, regardless of actual link state. |                    |             |                           |
| 3   | <b>ReadCplBoundary: read completion boundary.</b> Read-only. 0=64 byte read completion boundary.                                                                        |                    |             |                           |
| 2   | Reserved.                                                                                                                                                               |                    |             |                           |
| 1:0 | <b>PmControl: active state power management enable.</b> Read-write. This field controls the level of ASPM supported on the given IO link.                               |                    |             |                           |
|     | <u>Bits</u>                                                                                                                                                             | <u>Definition</u>  | <u>Bits</u> | <u>Definition</u>         |
|     | 00b                                                                                                                                                                     | Disabled.          | 10b         | L1 Entry Enabled.         |
|     | 01b                                                                                                                                                                     | L0s Entry Enabled. | 11b         | L0s and L1 Entry Enabled. |

### D[4:2]F[5:1]x6C Slot Capability Register

Reset: 0004\_0000h.

| Bits        | Description                                                                                                                                                                                                                                                                                                                                                                              |             |                   |             |                   |     |     |     |      |     |     |     |       |
|-------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|-------------------|-------------|-------------------|-----|-----|-----|------|-----|-----|-----|-------|
| 31:19       | <b>PhysicalSlotNumber: physical slot number.</b> Read-write.<br>This field indicates the physical slot number attached to this port. This field is set to a value that assigns a slot number that is unique within the chassis, regardless of the form factor associated with the slot. This field must be initialized to 0 for ports connected to devices that are on the system board. |             |                   |             |                   |     |     |     |      |     |     |     |       |
| 18          | <b>NoCmdCplSupport: no command completed support.</b> Read-write. 1 =Indicates that this slot does not generate software notification when an issued command is completed by the hot-plug controller.                                                                                                                                                                                    |             |                   |             |                   |     |     |     |      |     |     |     |       |
| 17          | <b>ElecMechIIPresent: electromechanical interlock present.</b> Read-write. 0=Indicates that a electro-mechanical interlock is not implemented for this slot.                                                                                                                                                                                                                             |             |                   |             |                   |     |     |     |      |     |     |     |       |
| 16:15       | <b>SlotPwrLimitScale: slot power limit scale.</b> Read-write. Specifies the scale used for the SlotPwrLimitValue. Range of Values: <table><tr><td><u>Bits</u></td><td><u>Definition</u></td><td><u>Bits</u></td><td><u>Definition</u></td></tr><tr><td>00b</td><td>1.0</td><td>10b</td><td>0.01</td></tr><tr><td>01b</td><td>0.1</td><td>11b</td><td>0.001</td></tr></table>             | <u>Bits</u> | <u>Definition</u> | <u>Bits</u> | <u>Definition</u> | 00b | 1.0 | 10b | 0.01 | 01b | 0.1 | 11b | 0.001 |
| <u>Bits</u> | <u>Definition</u>                                                                                                                                                                                                                                                                                                                                                                        | <u>Bits</u> | <u>Definition</u> |             |                   |     |     |     |      |     |     |     |       |
| 00b         | 1.0                                                                                                                                                                                                                                                                                                                                                                                      | 10b         | 0.01              |             |                   |     |     |     |      |     |     |     |       |
| 01b         | 0.1                                                                                                                                                                                                                                                                                                                                                                                      | 11b         | 0.001             |             |                   |     |     |     |      |     |     |     |       |
| 14:7        | <b>SlotPwrLimitValue: slot power limit value.</b> Read-write. In combination with the SlotPwrLimitScale value, specifies the upper limit on power supplied by slot. Power limit (in Watts) calculated by multiplying the value in this field by the value in the SlotPwrLimitScale field.                                                                                                |             |                   |             |                   |     |     |     |      |     |     |     |       |
| 6           | <b>HotplugCapable: hot-plug capability.</b> Read-write.1=Indicates that this slot is capable of supporting hot-plug operations.                                                                                                                                                                                                                                                          |             |                   |             |                   |     |     |     |      |     |     |     |       |
| 5           | <b>HotplugSurprise: hot-plug surprise.</b> Read-write. 1=Indicates that an adapter present in this slot might be removed from the system without any prior notification.                                                                                                                                                                                                                 |             |                   |             |                   |     |     |     |      |     |     |     |       |
| 4           | <b>PwrIndicatorPresent: power indicator present.</b> Read-write. 0=Indicates that a power indicator is not implemented for this slot.                                                                                                                                                                                                                                                    |             |                   |             |                   |     |     |     |      |     |     |     |       |
| 3           | <b>AttnIndicatorPresent: attention indicator present.</b> Read-write. 0=Indicates that a attention indicator is not implemented for this slot.                                                                                                                                                                                                                                           |             |                   |             |                   |     |     |     |      |     |     |     |       |
| 2           | <b>MrlSensorPresent: manual retention latch sensor present.</b> Read-write. 0=Indicates that a manual retention latch sensor is not implemented for this slot.                                                                                                                                                                                                                           |             |                   |             |                   |     |     |     |      |     |     |     |       |
| 1           | <b>PwrControllerPresent: power controller present.</b> Read-write. 0=A power controller is not implemented for this slot.                                                                                                                                                                                                                                                                |             |                   |             |                   |     |     |     |      |     |     |     |       |
| 0           | <b>AttnButtonPresent: attention button present.</b> Read-write. 0=An attention button is not implemented for this slot.                                                                                                                                                                                                                                                                  |             |                   |             |                   |     |     |     |      |     |     |     |       |



**D[4:2]F[5:1]x70 Slot Control and Status Register**

IF (D[4:2]F[5:1]x58[SlotImplemented]==0) THEN Reset: 0040\_0000h. ELSE Reset: 0000\_0000h. ENDIF.

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:25 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 24    | <b>DIStateChanged: data link layer state change.</b> Read; Write-1-to-clear. This bit is set when the value reported in the D[4:2]F[5:1]x68[DIActive] is changed. In response to a data link layer state changed event, software must read D[4:2]F[5:1]x68[DIActive] to determine if the link is active before initiating configuration cycles to the hot plugged device.                                                                                         |
| 23    | <b>ElecMechIISts: electromechanical interlock status.</b> Read-only.                                                                                                                                                                                                                                                                                                                                                                                              |
| 22    | <b>PresenceDetectState: presence detect state.</b> Read-only. This bit indicates the presence of an adapter in the slot based on the physical layer in-band presence detect mechanism. The in-band presence detect mechanism requires that power be applied to an adapter for its presence to be detected.<br>0=Slot empty.<br>1=Card present in slot.<br>For root ports not connected to slots (D[4:2]F[5:1]x58[SlotImplemented]=0b), this bit returns always 1. |
| 21    | <b>MrlSensorState.</b> Read-only.                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| 20    | <b>CmdCpl: command completed.</b> Read-only.                                                                                                                                                                                                                                                                                                                                                                                                                      |
| 19    | <b>PresenceDetectChanged: presence detect changes.</b> Read; Write-1-to-clear. This bit is set when the value reported in PresenceDetectState is changed.                                                                                                                                                                                                                                                                                                         |
| 18    | <b>MrlSensorChanged.</b> Read; Write-1-to-clear.                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 17    | <b>PwrFaultDetected.</b> Read; Write-1-to-clear.                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 16    | <b>AttnButtonPressed: attention button pressed.</b> Read-only.                                                                                                                                                                                                                                                                                                                                                                                                    |
| 15:13 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 12    | <b>DIStateChangedEn: data link layer state changed enable.</b> Read-write. 1=Enables software notification when D[4:2]F[5:1]x68[DIActive] is changed.                                                                                                                                                                                                                                                                                                             |
| 11    | <b>ElecMechIICntl: electromechanical interlock control.</b> Read-only.                                                                                                                                                                                                                                                                                                                                                                                            |
| 10    | <b>PwrControllerCntl: power controller control.</b> Read-only.                                                                                                                                                                                                                                                                                                                                                                                                    |
| 9:8   | <b>PwrIndicatorCntl: power indicator control.</b> Read-only.                                                                                                                                                                                                                                                                                                                                                                                                      |
| 7:6   | <b>AttnIndicatorControl: attention indicator control.</b> Read-only.                                                                                                                                                                                                                                                                                                                                                                                              |
| 5     | <b>HotplugIntrEn: hot-plug interrupt enable.</b> Read-only.                                                                                                                                                                                                                                                                                                                                                                                                       |
| 4     | <b>CmdCplIntrEn: command complete interrupt enable.</b> Read-only.                                                                                                                                                                                                                                                                                                                                                                                                |
| 3     | <b>PresenceDetectChangedEn: presence detect changed enable.</b> Read-only.                                                                                                                                                                                                                                                                                                                                                                                        |
| 2     | <b>MrlSensorChangedEn: manual retention latch sensor changed enable.</b> Read-only.                                                                                                                                                                                                                                                                                                                                                                               |
| 1     | <b>PwrFaultDetectedEn: power fault detected enable.</b> Read-only.                                                                                                                                                                                                                                                                                                                                                                                                |
| 0     | <b>AttnButtonPressedEn: attention button pressed enable.</b> Read-only.                                                                                                                                                                                                                                                                                                                                                                                           |

**D[4:2]F[5:1]x74 Root Complex Capability and Control Register**

Reset: 0001\_0000h.

| Bits  | Description                                                                                                                                                                                                                                                                            |
|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:17 | Reserved.                                                                                                                                                                                                                                                                              |
| 16    | <b>CrsSoftVisibility: CRS software visibility.</b> Read-only. 1=Indicates that the root port supports returning configuration request retry status (CRS) completion status to software.                                                                                                |
| 15:5  | Reserved.                                                                                                                                                                                                                                                                              |
| 4     | <b>CrsSoftVisibilityEn: CRS software visibility enable.</b> Read-write. 1=Enables the root port returning configuration request retry status (CRS) completion status to software.                                                                                                      |
| 3     | <b>PmIntEn: PME interrupt enable.</b> Read-write. 1=Enables interrupt generation upon receipt of a PME message as reflected D[4:2]F[5:1]x78[PmeStatus]. A PME interrupt is also generated if D[4:2]F[5:1]x78[PmeStatus]=1 and this bit is set by software.                             |
| 2     | <b>SerrOnFatalErrEn: system error on fatal error enable.</b> Read-write. 1=Indicates that a system error should be generated if a fatal error (ERR_FATAL) is reported by any of the devices in the hierarchy associated with this root port, or by the root port itself.               |
| 1     | <b>SerrOnNonFatalErrEn: system error on non-fatal error enable.</b> Read-write. 1=Indicates that a system error should be generated if a non-fatal error (ERR_NONFATAL) is reported by any of the devices in the hierarchy associated with this root port, or by the root port itself. |
| 0     | <b>SerrOnCorrErrEn: system error on correctable error enable.</b> Read-write. 1=Indicates that a system error should be generated if a correctable error (ERR_COR) is reported by any of the devices in the hierarchy associated with this root port, or by the root port itself.      |

**D[4:2]F[5:1]x78 Root Complex Status Register**

Reset: 0000\_0000h.

| Bits  | Description                                                                                                                                                                                                                                                                                                                             |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:18 | Reserved.                                                                                                                                                                                                                                                                                                                               |
| 17    | <b>PmePending: PME pending.</b> Read-only. This bit indicates that another PME is pending when PmeStatus is set. When PmeStatus is cleared by software; the PME is delivered by hardware by setting the PmeStatus bit again and updating the requestor ID appropriately. PmePending is cleared by hardware if no more PMEs are pending. |
| 16    | <b>PmeStatus: pme status.</b> Read; Write-1-to-clear. This bit indicates that PME was asserted by the requestor ID indicated in the PmeRequestorID field. Subsequent PMEs are kept pending until PmeStatus is cleared by writing a 1.                                                                                                   |
| 15:0  | <b>PmeRequestorId: pme requestor ID.</b> Read-only. This field indicates the PCI requestor ID of the last PME requestor.                                                                                                                                                                                                                |

**D[4:2]F[5:1]x7C Device Capability 2**

Reset: 0000\_0000h.

| Bits  | Description |
|-------|-------------|
| 31:24 | Reserved.   |

|             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |             |                         |  |             |                   |             |                   |     |                         |     |                         |     |                       |     |                         |
|-------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|-------------------------|--|-------------|-------------------|-------------|-------------------|-----|-------------------------|-----|-------------------------|-----|-----------------------|-----|-------------------------|
| 23:22       | <b>MaxEndEndTlpPrefixes: Max number of End-End TLP prefixes supported.</b> Read-only. IF (D[4:2]F[5:1]x7C[EndEndTlpPrefixSupported]==0) THEN Reserved. ENDIF.<br><table><tr><td><u>Bits</u></td><td><u>Definition</u></td><td><u>Bits</u></td><td><u>Definition</u></td></tr><tr><td>00b</td><td>4 End-End TLP Prefixes.</td><td>10b</td><td>2 End-End TLP Prefixes.</td></tr><tr><td>01b</td><td>1 End-End TLP Prefix.</td><td>11b</td><td>3 End-End TLP Prefixes.</td></tr></table> |             |                         |  | <u>Bits</u> | <u>Definition</u> | <u>Bits</u> | <u>Definition</u> | 00b | 4 End-End TLP Prefixes. | 10b | 2 End-End TLP Prefixes. | 01b | 1 End-End TLP Prefix. | 11b | 3 End-End TLP Prefixes. |
| <u>Bits</u> | <u>Definition</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <u>Bits</u> | <u>Definition</u>       |  |             |                   |             |                   |     |                         |     |                         |     |                       |     |                         |
| 00b         | 4 End-End TLP Prefixes.                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 10b         | 2 End-End TLP Prefixes. |  |             |                   |             |                   |     |                         |     |                         |     |                       |     |                         |
| 01b         | 1 End-End TLP Prefix.                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 11b         | 3 End-End TLP Prefixes. |  |             |                   |             |                   |     |                         |     |                         |     |                       |     |                         |
| 21          | <b>EndEndTlpPrefixSupported: End-End TLP Prefix supported.</b> Read-only.                                                                                                                                                                                                                                                                                                                                                                                                             |             |                         |  |             |                   |             |                   |     |                         |     |                         |     |                       |     |                         |
| 20          | <b>ExtendedFmtFieldSupported.</b> Read-only. 1=Supports the 3-bit definition of the Fmt field. 0=Supports the 2-bit definition of the Fmt field. Must be set for functions that support End-End TLP prefixes.                                                                                                                                                                                                                                                                         |             |                         |  |             |                   |             |                   |     |                         |     |                         |     |                       |     |                         |
| 19:18       | <b>ObffSupported: optimized buffer flush/fill supported.</b> Read-only.                                                                                                                                                                                                                                                                                                                                                                                                               |             |                         |  |             |                   |             |                   |     |                         |     |                         |     |                       |     |                         |
| 17:14       | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |             |                         |  |             |                   |             |                   |     |                         |     |                         |     |                       |     |                         |
| 13:12       | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |             |                         |  |             |                   |             |                   |     |                         |     |                         |     |                       |     |                         |
| 11          | <b>LtrSupported: latency tolerance supported.</b> Read-only.                                                                                                                                                                                                                                                                                                                                                                                                                          |             |                         |  |             |                   |             |                   |     |                         |     |                         |     |                       |     |                         |
| 10          | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |             |                         |  |             |                   |             |                   |     |                         |     |                         |     |                       |     |                         |
| 9:6         | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |             |                         |  |             |                   |             |                   |     |                         |     |                         |     |                       |     |                         |
| 5           | <b>AriForwardingSupported.</b> Read-only.                                                                                                                                                                                                                                                                                                                                                                                                                                             |             |                         |  |             |                   |             |                   |     |                         |     |                         |     |                       |     |                         |
| 4           | <b>CplTimeoutDisSup: completion timeout disable supported.</b> Read-only.                                                                                                                                                                                                                                                                                                                                                                                                             |             |                         |  |             |                   |             |                   |     |                         |     |                         |     |                       |     |                         |
| 3:0         | <b>CplTimeoutRangeSup: completion timeout range supported.</b> Read-only. Fh=Completion timeout range is 64s to 50us.                                                                                                                                                                                                                                                                                                                                                                 |             |                         |  |             |                   |             |                   |     |                         |     |                         |     |                       |     |                         |

## D[4:2]F[5:1]x80 Device Control and Status 2

Reset: 0000\_8000h.

| Bits  | Description                                                                                                                    |
|-------|--------------------------------------------------------------------------------------------------------------------------------|
| 31:16 | Reserved.                                                                                                                      |
| 15    | <b>EndEndTlpPrefixBlocking.</b> Read-only. 1=Forwarding of End-End TLP Prefixes is not supported. This bit is hardwired to 1b. |
| 14:13 | <b>ObffEn: optimized buffer flush/fill enable.</b> Read-write.                                                                 |
| 12:11 | Reserved.                                                                                                                      |
| 10    | <b>LtrEn: latency tolerance reporting enable.</b> Read-write.                                                                  |
| 9     | Reserved.                                                                                                                      |
| 8     | Reserved.                                                                                                                      |
| 7:6   | Reserved.                                                                                                                      |
| 5     | <b>AriForwardingEn.</b> Read-write.                                                                                            |

|     |                                                                                              |                      |             |                      |
|-----|----------------------------------------------------------------------------------------------|----------------------|-------------|----------------------|
| 4   | <b>CplTimeoutDis: completion timeout disable.</b> Read-write. 1=Completion timeout disabled. |                      |             |                      |
| 3:0 | <b>CplTimeoutValue: completion timeout value.</b> Read-write. BIOS: 6h.                      |                      |             |                      |
|     | <u>Bits</u>                                                                                  | <u>Timeout Range</u> | <u>Bits</u> | <u>Timeout Range</u> |
|     | 0h                                                                                           | 50ms-50us            | 9h          | 900ms-260ms          |
|     | 1h                                                                                           | 100us-50us           | Ah          | 3.5s-1s              |
|     | 2h                                                                                           | 10ms-1ms             | Ch-Bh       | Reserved             |
|     | 4h-3h                                                                                        | Reserved             | Dh          | 13s-4s               |
|     | 5h                                                                                           | 55ms-16ms            | Eh          | 64s-4s               |
|     | 6h                                                                                           | 210ms-65ms           | Fh          | Reserved             |
|     | 8h-7h                                                                                        | Reserved             |             |                      |

### D[4:2]F[5:1]x84 IO Link Capability 2

| Bits | Description                                                                                                         |
|------|---------------------------------------------------------------------------------------------------------------------|
| 31:9 | Reserved.                                                                                                           |
| 8    | <b>CrossLinkSupported.</b> Read-only. Reset: 0.                                                                     |
| 7:3  | Reserved.                                                                                                           |
| 2:1  | <b>SupportedLinkSpeed.</b> Read-only. Reset: 3h. Specifies the supported link speeds. Bit 1=2.5GT/s, Bit 2=5.0GT/s. |
| 0    | Reserved.                                                                                                           |

### D[4:2]F[5:1]x88 IO Link Control and Status 2

| Bits  | Description                                                                                                                                              |
|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:22 | Reserved.                                                                                                                                                |
| 21    | <b>LinkEqualizationRequest.</b> Read; write-1-to-clear. Reset: 0. 1=Hardware requests link equalization to be performed.                                 |
| 20    | <b>EqualizationPhase3Success.</b> Read-only. Reset: 0. 1=Phase 3 of the Transmitter Equalization procedure has completed successfully. Write 1 to clear. |
| 19    | <b>EqualizationPhase2Success.</b> Read-only. Reset: 0. 1=Phase 2 of the Transmitter Equalization procedure has completed successfully. Write 1 to clear. |
| 18    | <b>EqualizationPhase1Success.</b> Read-only. Reset: 0. 1=Phase 1 of the Transmitter Equalization procedure has completed successfully. Write 1 to clear. |
| 17    | <b>EqualizationComplete.</b> Read-only. Reset: 0. 1=Transmitter Equalization procedure has completed. Write 1 to clear.                                  |
| 16    | <b>CurDeemphasisLevel: current deemphasis level.</b> Read-only. Reset: D[4:2]F[5:1]xE4_xA4[LcGen2EnStrap]. 1=-3.5 dB. 0=-6 dB                            |

| 15:12       | <b>ComplianceDeemphasis: compliance deemphasis.</b> Read-write. Reset: 0. In Gen2 this field defines the compliance deemphasis level when EnterCompliance is set. Software should leave this field in its default state.<br><table> <tr> <th><u>Bits</u></th><th><u>Definition</u></th></tr> <tr> <td>0h</td><td>DeEmph=-6 dB, Preshoot=0 dB</td></tr> <tr> <td>1h</td><td>DeEmph=-3.5 dB, Preshoot=0 dB</td></tr> <tr> <td>2h</td><td>DeEmph=-4.5 dB, Preshoot=0 dB</td></tr> <tr> <td>3h</td><td>DeEmph=-2.5 dB, Preshoot=0 dB</td></tr> <tr> <td>4h</td><td>DeEmph=-0 dB, Preshoot=0 dB</td></tr> <tr> <td>5h</td><td>DeEmph=-0 dB, Preshoot=2 dB</td></tr> <tr> <td>6h</td><td>DeEmph=-0 dB, Preshoot=2.5 dB</td></tr> <tr> <td>7h</td><td>DeEmph=-6 dB, Preshoot=3.5 dB</td></tr> <tr> <td>8h</td><td>DeEmph=-3.5 dB, Preshoot=3.5 dB</td></tr> <tr> <td>9h</td><td>DeEmph=-0 dB, Preshoot=3.5 dB</td></tr> <tr> <td>Fh-Ah</td><td>Reserved.</td></tr> </table> | <u>Bits</u> | <u>Definition</u> | 0h | DeEmph=-6 dB, Preshoot=0 dB | 1h | DeEmph=-3.5 dB, Preshoot=0 dB | 2h | DeEmph=-4.5 dB, Preshoot=0 dB | 3h | DeEmph=-2.5 dB, Preshoot=0 dB | 4h    | DeEmph=-0 dB, Preshoot=0 dB | 5h | DeEmph=-0 dB, Preshoot=2 dB | 6h | DeEmph=-0 dB, Preshoot=2.5 dB | 7h | DeEmph=-6 dB, Preshoot=3.5 dB | 8h | DeEmph=-3.5 dB, Preshoot=3.5 dB | 9h | DeEmph=-0 dB, Preshoot=3.5 dB | Fh-Ah | Reserved. |
|-------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|-------------------|----|-----------------------------|----|-------------------------------|----|-------------------------------|----|-------------------------------|-------|-----------------------------|----|-----------------------------|----|-------------------------------|----|-------------------------------|----|---------------------------------|----|-------------------------------|-------|-----------|
| <u>Bits</u> | <u>Definition</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |             |                   |    |                             |    |                               |    |                               |    |                               |       |                             |    |                             |    |                               |    |                               |    |                                 |    |                               |       |           |
| 0h          | DeEmph=-6 dB, Preshoot=0 dB                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |             |                   |    |                             |    |                               |    |                               |    |                               |       |                             |    |                             |    |                               |    |                               |    |                                 |    |                               |       |           |
| 1h          | DeEmph=-3.5 dB, Preshoot=0 dB                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |             |                   |    |                             |    |                               |    |                               |    |                               |       |                             |    |                             |    |                               |    |                               |    |                                 |    |                               |       |           |
| 2h          | DeEmph=-4.5 dB, Preshoot=0 dB                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |             |                   |    |                             |    |                               |    |                               |    |                               |       |                             |    |                             |    |                               |    |                               |    |                                 |    |                               |       |           |
| 3h          | DeEmph=-2.5 dB, Preshoot=0 dB                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |             |                   |    |                             |    |                               |    |                               |    |                               |       |                             |    |                             |    |                               |    |                               |    |                                 |    |                               |       |           |
| 4h          | DeEmph=-0 dB, Preshoot=0 dB                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |             |                   |    |                             |    |                               |    |                               |    |                               |       |                             |    |                             |    |                               |    |                               |    |                                 |    |                               |       |           |
| 5h          | DeEmph=-0 dB, Preshoot=2 dB                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |             |                   |    |                             |    |                               |    |                               |    |                               |       |                             |    |                             |    |                               |    |                               |    |                                 |    |                               |       |           |
| 6h          | DeEmph=-0 dB, Preshoot=2.5 dB                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |             |                   |    |                             |    |                               |    |                               |    |                               |       |                             |    |                             |    |                               |    |                               |    |                                 |    |                               |       |           |
| 7h          | DeEmph=-6 dB, Preshoot=3.5 dB                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |             |                   |    |                             |    |                               |    |                               |    |                               |       |                             |    |                             |    |                               |    |                               |    |                                 |    |                               |       |           |
| 8h          | DeEmph=-3.5 dB, Preshoot=3.5 dB                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |             |                   |    |                             |    |                               |    |                               |    |                               |       |                             |    |                             |    |                               |    |                               |    |                                 |    |                               |       |           |
| 9h          | DeEmph=-0 dB, Preshoot=3.5 dB                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |             |                   |    |                             |    |                               |    |                               |    |                               |       |                             |    |                             |    |                               |    |                               |    |                                 |    |                               |       |           |
| Fh-Ah       | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |             |                   |    |                             |    |                               |    |                               |    |                               |       |                             |    |                             |    |                               |    |                               |    |                                 |    |                               |       |           |
| 11          | <b>ComplianceSOS: compliance SOS.</b> Read-write. Reset: 0. 1=The device transmits skip ordered sets in between the modified compliance pattern.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |             |                   |    |                             |    |                               |    |                               |    |                               |       |                             |    |                             |    |                               |    |                               |    |                                 |    |                               |       |           |
| 10          | <b>EnterModCompliance: enter modified compliance.</b> Read-write. Reset: 0. 1=The device transmits modified compliance pattern. Software should leave this field in its default state.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |             |                   |    |                             |    |                               |    |                               |    |                               |       |                             |    |                             |    |                               |    |                               |    |                                 |    |                               |       |           |
| 9:7         | <b>XmitMargin: transmit margin.</b> Read-write. Reset: 0. This field controls the non-deemphasized voltage level at the transmitter pins. Software should leave this field in its default state.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |             |                   |    |                             |    |                               |    |                               |    |                               |       |                             |    |                             |    |                               |    |                               |    |                                 |    |                               |       |           |
| 6           | <b>SelectableDeemphasis: selectable deemphasis.</b> Read-only. Reset: <a href="#">D[4:2]F[5:1]xE4_xA4[LcGen2EnStrap]</a> . 0=Selectable deemphasis is not supported. 1=Selectable deemphasis supported.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |             |                   |    |                             |    |                               |    |                               |    |                               |       |                             |    |                             |    |                               |    |                               |    |                                 |    |                               |       |           |
| 5           | <b>HwAutonomousSpeedDisable: hardware autonomous speed disable.</b> Read-write. Cold reset: 0. 1=Support for hardware changing the link speed for device specific reasons disabled.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |             |                   |    |                             |    |                               |    |                               |    |                               |       |                             |    |                             |    |                               |    |                               |    |                                 |    |                               |       |           |
| 4           | <b>EnterCompliance: enter compliance.</b> Read-write. Cold reset: 0. 1=Force the link to enter the compliance mode.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |             |                   |    |                             |    |                               |    |                               |    |                               |       |                             |    |                             |    |                               |    |                               |    |                                 |    |                               |       |           |
| 3:0         | <b>TargetLinkSpeed: target link speed.</b> Read-write. Reset: 2h.<br>This field defines the upper limit of the link operational speed. Writes of reserved encodings are not valid. Hardware prevents writes of reserved encodings from changing the state of this field.<br><table> <tr> <th><u>Bits</u></th><th><u>Definition</u></th></tr> <tr> <td>0h</td><td>Reserved</td></tr> <tr> <td>1h</td><td>2.5GT/s</td></tr> <tr> <td>2h</td><td>5.0GT/s</td></tr> <tr> <td>3h</td><td>8.0GT/s</td></tr> <tr> <td>Fh-4h</td><td>Reserved</td></tr> </table>                                                                                                                                                                                                                                                                                                                                                                                                             | <u>Bits</u> | <u>Definition</u> | 0h | Reserved                    | 1h | 2.5GT/s                       | 2h | 5.0GT/s                       | 3h | 8.0GT/s                       | Fh-4h | Reserved                    |    |                             |    |                               |    |                               |    |                                 |    |                               |       |           |
| <u>Bits</u> | <u>Definition</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |             |                   |    |                             |    |                               |    |                               |    |                               |       |                             |    |                             |    |                               |    |                               |    |                                 |    |                               |       |           |
| 0h          | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |             |                   |    |                             |    |                               |    |                               |    |                               |       |                             |    |                             |    |                               |    |                               |    |                                 |    |                               |       |           |
| 1h          | 2.5GT/s                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |             |                   |    |                             |    |                               |    |                               |    |                               |       |                             |    |                             |    |                               |    |                               |    |                                 |    |                               |       |           |
| 2h          | 5.0GT/s                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |             |                   |    |                             |    |                               |    |                               |    |                               |       |                             |    |                             |    |                               |    |                               |    |                                 |    |                               |       |           |
| 3h          | 8.0GT/s                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |             |                   |    |                             |    |                               |    |                               |    |                               |       |                             |    |                             |    |                               |    |                               |    |                                 |    |                               |       |           |
| Fh-4h       | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |             |                   |    |                             |    |                               |    |                               |    |                               |       |                             |    |                             |    |                               |    |                               |    |                                 |    |                               |       |           |

### **D[4:2]F[5:1]x8C Slot Capability 2**

Reset: 0000\_0000h.

| Bits | Description |
|------|-------------|
| 31:0 | Reserved.   |

**D[4:2]F[5:1]x90 Slot Control and Status 2**

Reset: 0000\_0000h.

| Bits | Description |
|------|-------------|
| 31:0 | Reserved.   |

**D[4:2]F[5:1]xA0 MSI Capability Register**

Reset: 0000\_B005h.

| Bits  | Description                                                                                                                                                                                                                                                    |
|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:24 | Reserved.                                                                                                                                                                                                                                                      |
| 23    | <b>Msi64bit: MSI 64 bit capability.</b> Read-only. 1=The device is capable of sending 64-bit MSI messages. 0=The device is not capable of sending a 64-bit message address.                                                                                    |
| 22:20 | <b>MsiMultiEn: MSI multiple message enable.</b> Read-write. Software writes to this field to indicate the number of allocated vectors (equal to or less than the number of requested vectors). When MSI is enabled, a function is allocated at least 1 vector. |
| 19:17 | <b>MsiMultiCap: MSI multiple message capability.</b> Read-only. 000b=The device is requesting one vector.                                                                                                                                                      |
| 16    | <b>MsiEn: MSI enable.</b> Read-write. 1=MSI generation is enabled and INTx generation is disabled. 0=MSI generation disabled and INTx generation is enabled.                                                                                                   |
| 15:8  | <b>NextPtr: next pointer.</b> Read-only.                                                                                                                                                                                                                       |
| 7:0   | <b>CapID: capability ID.</b> Read-only. 05h=MSI capability structure.                                                                                                                                                                                          |

**D[4:2]F[5:1]xA4 MSI Message Address Low**

Reset: 0000\_0000h.

| Bits | Description                                                                                                                                   |
|------|-----------------------------------------------------------------------------------------------------------------------------------------------|
| 31:2 | <b>MsiMsgAddrLo: MSI message address.</b> Read-write. This register specifies the dword aligned address for the MSI memory write transaction. |
| 1:0  | Reserved.                                                                                                                                     |

**D[4:2]F[5:1]xA8 MSI Message Address High**

Reset: 0000\_0000h.

| Bits | Description                                                                                                         |
|------|---------------------------------------------------------------------------------------------------------------------|
| 31:0 | <b>MsiMsgAddrHi: MSI message address.</b> Read-write. This register specifies the upper 32-bits of the MSI address. |

**D[4:2]F[5:1]xAC MSI Message Data**

Reset: 0000\_0000h.

| Bits  | Description                                                                                                                                                       |
|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:16 | Reserved.                                                                                                                                                         |
| 15:0  | <b>MsiData: MSI message data.</b> Read-write. This register specifies lower 16 bits of data for the MSI memory write transaction. The upper 16 bits are always 0. |

**D[4:2]F[5:1]xB0 Subsystem and Subvendor Capability ID Register**

Reset: 0000\_B80Dh.

| Bits  | Description                              |
|-------|------------------------------------------|
| 31:16 | Reserved.                                |
| 15:8  | <b>NextPtr: next pointer.</b> Read-only. |
| 7:0   | <b>CapID: capability ID.</b> Read-only.  |

**D[4:2]F[5:1]xB4 Subsystem and Subvendor ID Register**

Reset: 0000\_0000h.

| Bits  | Description                          |
|-------|--------------------------------------|
| 31:16 | <b>SubsystemID.</b> Read-only.       |
| 15:0  | <b>SubsystemVendorID.</b> Read-only. |

**D[4:2]F[5:1]xB8 MSI Capability Mapping**

Reset: A803\_0008h.

| Bits  | Description                                 |
|-------|---------------------------------------------|
| 31:27 | <b>CapType: capability type.</b> Read-only. |
| 26:18 | Reserved.                                   |
| 17    | <b>FixD.</b> Read-only.                     |
| 16    | <b>En.</b> Read-only.                       |
| 15:8  | <b>NextPtr: next pointer.</b> Read-only.    |
| 7:0   | <b>CapID: capability ID.</b> Read-only.     |

**D[4:2]F[5:1]xBC MSI Mapping Address Low**

| Bits  | Description                                                                 |
|-------|-----------------------------------------------------------------------------|
| 31:20 | <b>MsiMapAddrLo.</b> Read-only. Reset: 0. Lower 32-bits of the MSI address. |
| 19:0  | Reserved.                                                                   |

**D[4:2]F[5:1]xC0 MSI Mapping Address High**

| Bits | Description                                                                  |
|------|------------------------------------------------------------------------------|
| 31:0 | <b>MsiMapAddrHi</b> . Read-only. Reset: 0. Upper 32-bits of the MSI address. |

**D[4:2]F[5:1]xE0 Root Port Index**

Reset: 0000\_0000h.

The index/data pair registers, [D\[4:2\]F\[5:1\]xE0](#) and [D\[4:2\]F\[5:1\]xE4](#), are used to access the registers at [D\[4:2\]F\[5:1\]xE4\\_x\[FF:00\]](#). To access any of these registers, the address is first written into the index register, [D\[4:2\]F\[5:1\]xE0](#), and then the data is read from or written to the data register, [D\[4:2\]F\[5:1\]xE4](#).

| Bits | Description                    |
|------|--------------------------------|
| 31:8 | Reserved.                      |
| 7:0  | <b>PcieIndex</b> . Read-write. |

**D[4:2]F[5:1]xE4 Root Port Data**See [D\[4:2\]F\[5:1\]xE0](#). Address: [D\[4:2\]F\[5:1\]xE0\[PcieIndex\]](#).

| Bits | Description                   |
|------|-------------------------------|
| 31:0 | <b>PcieData</b> . Read-write. |

**D[4:2]F[5:1]xE4\_x20 Root Port TX Control**

Reset: 0050\_8000h.

| Bits  | Description                                                                                          |
|-------|------------------------------------------------------------------------------------------------------|
| 31:16 | Reserved.                                                                                            |
| 15    | <b>TxFlushTlpDis: TLP flush disable</b> . Read-write. 1=Disable flushing TLPs when the link is down. |
| 14:0  | Reserved.                                                                                            |

**D[4:2]F[5:1]xE4\_x50 Root Port Lane Status**

Reset: 0000\_0000h.

| Bits | Description                                                                             |                   |             |                   |
|------|-----------------------------------------------------------------------------------------|-------------------|-------------|-------------------|
| 31:7 | Reserved.                                                                               |                   |             |                   |
| 6:1  | <b>PhyLinkWidth: port link width.</b> Read-only; updated-by-hardware.                   |                   |             |                   |
|      | <u>Bits</u>                                                                             | <u>Definition</u> | <u>Bits</u> | <u>Definition</u> |
|      | 00_0000b                                                                                | disabled          | 00_1000b    | x8                |
|      | 00_0001b                                                                                | x1                | 01_0000b    | x12               |
|      | 00_0010b                                                                                | x2                | 10_0000b    | x16               |
|      | 00_0100b                                                                                | x4                |             |                   |
| 0    | <b>PortLaneReversal: port lane reversal.</b> Read-only. 1=Port lanes order is reversed. |                   |             |                   |



**D[4:2]F[5:1]xE4\_x6A Root Port Error Control**

Reset: 0000\_0500h.

| Bits | Description                                                                                                                           |
|------|---------------------------------------------------------------------------------------------------------------------------------------|
| 31:1 | Reserved.                                                                                                                             |
| 0    | <b>ErrReportingDis: advanced error reporting disable.</b> Read-write. BIOS: 1. 1=Error reporting disabled. 0=Error reporting enabled. |

**D[4:2]F[5:1]xE4\_x70 Root Port Receiver Control**

Reset: 0188\_4000h.

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                   |      |            |      |            |      |          |      |      |      |      |      |       |      |      |      |       |      |      |      |     |
|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------------|------|------------|------|----------|------|------|------|------|------|-------|------|------|------|-------|------|------|------|-----|
| 31:20 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                     |      |            |      |            |      |          |      |      |      |      |      |       |      |      |      |       |      |      |      |     |
| 19    | <b>RxRcbCplTimeoutMode: RCB completion timeout mode.</b> Read-write. BIOS: 1. 1=Timeout on link down.                                                                                                                                                                                                                                                                                                         |      |            |      |            |      |          |      |      |      |      |      |       |      |      |      |       |      |      |      |     |
| 18:16 | <b>RxRcbCplTimeout: RCB completion timeout.</b> Read-write. <table><tr><th>Bits</th><th>Definition</th><th>Bits</th><th>Definition</th></tr><tr><td>000b</td><td>Disabled</td><td>100b</td><td>50ms</td></tr><tr><td>001b</td><td>50us</td><td>101b</td><td>100ms</td></tr><tr><td>010b</td><td>10ms</td><td>110b</td><td>500ms</td></tr><tr><td>011b</td><td>25ms</td><td>111b</td><td>1ms</td></tr></table> | Bits | Definition | Bits | Definition | 000b | Disabled | 100b | 50ms | 001b | 50us | 101b | 100ms | 010b | 10ms | 110b | 500ms | 011b | 25ms | 111b | 1ms |
| Bits  | Definition                                                                                                                                                                                                                                                                                                                                                                                                    | Bits | Definition |      |            |      |          |      |      |      |      |      |       |      |      |      |       |      |      |      |     |
| 000b  | Disabled                                                                                                                                                                                                                                                                                                                                                                                                      | 100b | 50ms       |      |            |      |          |      |      |      |      |      |       |      |      |      |       |      |      |      |     |
| 001b  | 50us                                                                                                                                                                                                                                                                                                                                                                                                          | 101b | 100ms      |      |            |      |          |      |      |      |      |      |       |      |      |      |       |      |      |      |     |
| 010b  | 10ms                                                                                                                                                                                                                                                                                                                                                                                                          | 110b | 500ms      |      |            |      |          |      |      |      |      |      |       |      |      |      |       |      |      |      |     |
| 011b  | 25ms                                                                                                                                                                                                                                                                                                                                                                                                          | 111b | 1ms        |      |            |      |          |      |      |      |      |      |       |      |      |      |       |      |      |      |     |
| 15:0  | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                     |      |            |      |            |      |          |      |      |      |      |      |       |      |      |      |       |      |      |      |     |

**D[4:2]F[5:1]xE4\_xA0 Per Port Link Controller (LC) Control**

Reset: 4000\_0030h.

| Bits        | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |             |                   |             |                   |    |             |    |       |    |     |    |     |    |     |    |      |    |     |    |      |    |      |    |      |    |      |    |       |    |      |    |       |    |       |    |          |
|-------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|-------------------|-------------|-------------------|----|-------------|----|-------|----|-----|----|-----|----|-----|----|------|----|-----|----|------|----|------|----|------|----|------|----|-------|----|------|----|-------|----|-------|----|----------|
| 31:24       | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |             |                   |             |                   |    |             |    |       |    |     |    |     |    |     |    |      |    |     |    |      |    |      |    |      |    |      |    |       |    |      |    |       |    |       |    |          |
| 23          | <b>LcL1ImmediateAck: immediate ACK ASPM L1 entry.</b> Read-write. BIOS: 1. 1=Alwyas ACK ASPM L1 entry DLLPs.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |             |                   |             |                   |    |             |    |       |    |     |    |     |    |     |    |      |    |     |    |      |    |      |    |      |    |      |    |       |    |      |    |       |    |       |    |          |
| 22:16       | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |             |                   |             |                   |    |             |    |       |    |     |    |     |    |     |    |      |    |     |    |      |    |      |    |      |    |      |    |       |    |      |    |       |    |       |    |          |
| 15:12       | <b>LcL1Inactivity: L1 inactivity timer.</b> Read-write. <table><tr><th><u>Bits</u></th><th><u>Definition</u></th><th><u>Bits</u></th><th><u>Definition</u></th></tr><tr><td>0h</td><td>L1 disabled</td><td>8h</td><td>400us</td></tr><tr><td>1h</td><td>1us</td><td>9h</td><td>1ms</td></tr><tr><td>2h</td><td>2us</td><td>Ah</td><td>40us</td></tr><tr><td>3h</td><td>4us</td><td>Bh</td><td>10ms</td></tr><tr><td>4h</td><td>10us</td><td>Ch</td><td>40ms</td></tr><tr><td>5h</td><td>20us</td><td>Dh</td><td>100ms</td></tr><tr><td>6h</td><td>40us</td><td>Eh</td><td>400ms</td></tr><tr><td>7h</td><td>100us</td><td>Fh</td><td>reserved</td></tr></table> | <u>Bits</u> | <u>Definition</u> | <u>Bits</u> | <u>Definition</u> | 0h | L1 disabled | 8h | 400us | 1h | 1us | 9h | 1ms | 2h | 2us | Ah | 40us | 3h | 4us | Bh | 10ms | 4h | 10us | Ch | 40ms | 5h | 20us | Dh | 100ms | 6h | 40us | Eh | 400ms | 7h | 100us | Fh | reserved |
| <u>Bits</u> | <u>Definition</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <u>Bits</u> | <u>Definition</u> |             |                   |    |             |    |       |    |     |    |     |    |     |    |      |    |     |    |      |    |      |    |      |    |      |    |       |    |      |    |       |    |       |    |          |
| 0h          | L1 disabled                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 8h          | 400us             |             |                   |    |             |    |       |    |     |    |     |    |     |    |      |    |     |    |      |    |      |    |      |    |      |    |       |    |      |    |       |    |       |    |          |
| 1h          | 1us                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 9h          | 1ms               |             |                   |    |             |    |       |    |     |    |     |    |     |    |      |    |     |    |      |    |      |    |      |    |      |    |       |    |      |    |       |    |       |    |          |
| 2h          | 2us                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Ah          | 40us              |             |                   |    |             |    |       |    |     |    |     |    |     |    |      |    |     |    |      |    |      |    |      |    |      |    |       |    |      |    |       |    |       |    |          |
| 3h          | 4us                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Bh          | 10ms              |             |                   |    |             |    |       |    |     |    |     |    |     |    |      |    |     |    |      |    |      |    |      |    |      |    |       |    |      |    |       |    |       |    |          |
| 4h          | 10us                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Ch          | 40ms              |             |                   |    |             |    |       |    |     |    |     |    |     |    |      |    |     |    |      |    |      |    |      |    |      |    |       |    |      |    |       |    |       |    |          |
| 5h          | 20us                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Dh          | 100ms             |             |                   |    |             |    |       |    |     |    |     |    |     |    |      |    |     |    |      |    |      |    |      |    |      |    |       |    |      |    |       |    |       |    |          |
| 6h          | 40us                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Eh          | 400ms             |             |                   |    |             |    |       |    |     |    |     |    |     |    |      |    |     |    |      |    |      |    |      |    |      |    |       |    |      |    |       |    |       |    |          |
| 7h          | 100us                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Fh          | reserved          |             |                   |    |             |    |       |    |     |    |     |    |     |    |      |    |     |    |      |    |      |    |      |    |      |    |       |    |      |    |       |    |       |    |          |

|      |                                                                                                    |                   |             |                   |
|------|----------------------------------------------------------------------------------------------------|-------------------|-------------|-------------------|
| 11:8 | <b>LcL0sInactivity: L0s inactivity timer.</b> Read-write.                                          |                   |             |                   |
|      | <u>Bits</u>                                                                                        | <u>Definition</u> | <u>Bits</u> | <u>Definition</u> |
|      | 0h                                                                                                 | L0s disabled      | 8h          | 4us               |
|      | 1h                                                                                                 | 40ns              | 9h          | 10us              |
|      | 2h                                                                                                 | 80ns              | Ah          | 40us              |
|      | 3h                                                                                                 | 120ns             | Bh          | 100us             |
|      | 4h                                                                                                 | 200ns             | Ch          | 400us             |
|      | 5h                                                                                                 | 400ns             | Dh          | 1ms               |
|      | 6h                                                                                                 | 1us               | Eh          | 4ms               |
|      | 7h                                                                                                 | 2us               | Fh          | reserved          |
| 7:4  | <b>Lc16xClearTxPipe.</b> Read-write. BIOS: 1h. Specifies the number of clock to drain the TX pipe. |                   |             |                   |
| 3:0  | Reserved.                                                                                          |                   |             |                   |

**D[4:2]F[5:1]xE4\_xA1 LC Training Control**

Reset: 9400\_1880h.

| Bits  | Description                                                                                                                                                                                               |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:12 | Reserved.                                                                                                                                                                                                 |
| 11    | <b>LcDontGotoL0sifL1Armed: prevent Ls0 entry is L1 request in progress.</b> Read-write. BIOS: 1. 1=Prevent the LTSSM from transitioning to Rcv_L0s if an acknowledged request to enter L1 is in progress. |
| 10:0  | Reserved.                                                                                                                                                                                                 |

**D[4:2]F[5:1]xE4\_xA2 LC Link Width Control**

Reset: 00A0\_0006h.

| Bits        | Description                                                                                                                                                                                                                                                                                                                                                       |             |                   |             |                   |     |    |     |     |     |     |     |     |
|-------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|-------------------|-------------|-------------------|-----|----|-----|-----|-----|-----|-----|-----|
| 31:24       | Reserved.                                                                                                                                                                                                                                                                                                                                                         |             |                   |             |                   |     |    |     |     |     |     |     |     |
| 23          | Reserved.                                                                                                                                                                                                                                                                                                                                                         |             |                   |             |                   |     |    |     |     |     |     |     |     |
| 22:21       | <b>LcDynLanesPwrState: unused link power state.</b> Read-write. Controls the state of unused links after a reconfiguration. <table><tr><th><u>Bits</u></th><th><u>Definition</u></th><th><u>Bits</u></th><th><u>Definition</u></th></tr><tr><td>00b</td><td>on</td><td>10b</td><td>SB2</td></tr><tr><td>01b</td><td>SB1</td><td>11b</td><td>Off</td></tr></table> | <u>Bits</u> | <u>Definition</u> | <u>Bits</u> | <u>Definition</u> | 00b | on | 10b | SB2 | 01b | SB1 | 11b | Off |
| <u>Bits</u> | <u>Definition</u>                                                                                                                                                                                                                                                                                                                                                 | <u>Bits</u> | <u>Definition</u> |             |                   |     |    |     |     |     |     |     |     |
| 00b         | on                                                                                                                                                                                                                                                                                                                                                                | 10b         | SB2               |             |                   |     |    |     |     |     |     |     |     |
| 01b         | SB1                                                                                                                                                                                                                                                                                                                                                               | 11b         | Off               |             |                   |     |    |     |     |     |     |     |     |
| 20          | <b>LcUpconfigCapable: upconfigure capable.</b> Read-only; updated-by-hardware. 1=Both ends of the link are upconfigure capable. 0=Both ends of the link are not upconfigure capable.                                                                                                                                                                              |             |                   |             |                   |     |    |     |     |     |     |     |     |
| 19:14       | Reserved.                                                                                                                                                                                                                                                                                                                                                         |             |                   |             |                   |     |    |     |     |     |     |     |     |
| 13          | <b>LcUpconfigureDis: upconfigure disable.</b> Read-write. 1=Disable link upconfigure.                                                                                                                                                                                                                                                                             |             |                   |             |                   |     |    |     |     |     |     |     |     |
| 12          | <b>LcUpconfigureSupport: upconfigure support.</b> Read-write.                                                                                                                                                                                                                                                                                                     |             |                   |             |                   |     |    |     |     |     |     |     |     |
| 11          | <b>LcShortReconfigEn: short re-configuration enable.</b> Read-write. 1=Enable short link re-configuration                                                                                                                                                                                                                                                         |             |                   |             |                   |     |    |     |     |     |     |     |     |
| 10          | <b>LcRenegotiateEn: link reconfiguration enable.</b> Read-write. 1=Enable link re-negotiation.                                                                                                                                                                                                                                                                    |             |                   |             |                   |     |    |     |     |     |     |     |     |
| 9           | <b>LcRenegotiationSupport: re-negotiation support.</b> Read-only; updated-by-hardware. 1=Link re-negotiation not supported by the downstream device.                                                                                                                                                                                                              |             |                   |             |                   |     |    |     |     |     |     |     |     |

|     |                                                                                                                                  |                   |             |                   |
|-----|----------------------------------------------------------------------------------------------------------------------------------|-------------------|-------------|-------------------|
| 8   | <b>LcReconfigNow: re-configure link.</b> Read-write; cleared-when-done. 1=Initiate link width change.                            |                   |             |                   |
| 7   | <b>LcReconfigArcMissingEscape.</b> Read-write. 1=Expedite transition from Recovery.Idle to Detect during a long reconfiguration. |                   |             |                   |
| 6:4 | <b>LcLinkWidthRd: current link width.</b> Read-only; updated-by-hardware.                                                        |                   |             |                   |
|     | <u>Bits</u>                                                                                                                      | <u>Definition</u> | <u>Bits</u> | <u>Definition</u> |
|     | 000b                                                                                                                             | 0                 | 100b        | 8                 |
|     | 001b                                                                                                                             | 1                 | 101b        | 12                |
|     | 010b                                                                                                                             | 2                 | 110b        | 16                |
|     | 011b                                                                                                                             | 4                 | 111b        | Reserved          |
| 3   | Reserved.                                                                                                                        |                   |             |                   |
| 2:0 | <b>LcLinkWidth: link width required.</b> Read-write. See: LcLinkWidthRd.                                                         |                   |             |                   |

#### D[4:2]F[5:1]xE4\_xA3 LC Number of FTS Control

Reset: 00FF\_020Ch.

| Bits  | Description                                                                                                                                 |
|-------|---------------------------------------------------------------------------------------------------------------------------------------------|
| 31:10 | Reserved.                                                                                                                                   |
| 9     | <b>LcXmitFtsBeforeRecovery: transmit FTS before recovery.</b> Read-write. 1=Transmit FTS before recovery.                                   |
| 8     | <b>LcXmitNFtsOverrideEn: number of FTS override enable.</b> Read-write. BIOS: 1. 1=Override the number of FTS specified by the strap value. |
| 7:0   | <b>LcXmitNFts: number of FTS.</b> Read-write. BIOS: 40h. Specifies the number of FTS to sent if LcXmitNFtsOverrideEn=1.                     |

#### D[4:2]F[5:1]xE4\_xA4 LC Link Speed Control

Reset: 0440\_0100h.

| Bits  | Description                                                                                                                                                                                                                                               |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:28 | Reserved.                                                                                                                                                                                                                                                 |
| 27    | <b>LcMultUpstreamAutoSpdChngEn: enable multiple automatic speed changes.</b> Read-write. 1=Enable multiple automatic speed changes when D[4:2]F[5:1]xE4_xC0[StrapAutoRcSpeedNegotiationDis]=0 and no failures occurred in previous speed change attempts. |
| 26:20 | Reserved.                                                                                                                                                                                                                                                 |
| 19    | <b>LcOtherSideSupportsGen2: downstream link supports gen2.</b> Read-only; updated-by-hardware. 1=The downstream link currently supports gen2.                                                                                                             |
| 18:15 | Reserved.                                                                                                                                                                                                                                                 |
| 14:13 | Reserved.                                                                                                                                                                                                                                                 |
| 12    | <b>LcSpeedChangeAttemptFailed: speed change attempt failed.</b> Read-only; updated-by-hardware. 1=LcSpeedChangeAttemptsAllowed has been reached.                                                                                                          |
| 11:10 | Reserved.                                                                                                                                                                                                                                                 |
| 9     | <b>LcInitiateLinkSpeedChange: initiate link speed change.</b> Read-write; cleared-when-done. 1=Initiate link speed negotiation.                                                                                                                           |
| 8:7   | Reserved.                                                                                                                                                                                                                                                 |

|     |                                                                                                                                                                  |
|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 6   | <b>LcForceDisSwSpeedChange: force disable software speed changes.</b> Read-write. 1=Force the PCIe core to disable speed changes initiated by private registers. |
| 5:2 | Reserved.                                                                                                                                                        |
| 1   | <b>LcGen3EnStrap: Gen3 PCIe support enable.</b> Read-write. 1=Gen3 PCIe support enabled. 0=Gen3 PCIe support disabled.                                           |
| 0   | <b>LcGen2EnStrap: Gen2 PCIe support enable.</b> Read-write. 1=Gen2 PCIe support enabled. 0=Gen2 PCIe support disabled.                                           |

**D[4:2]F[5:1]xE4\_xA5 LC State 0**

Cold reset: 0000\_0000h.

| Bits  | Description                                                                                                                                    |
|-------|------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:30 | Reserved.                                                                                                                                      |
| 29:24 | <b>LcPrevState3: previous link state 3.</b> Read-only; updated-by-hardware. See: <a href="#">Table 112 [Link controller state encodings]</a> . |
| 23:22 | Reserved.                                                                                                                                      |
| 21:16 | <b>LcPrevState2: previous link state 2.</b> Read-only; updated-by-hardware. See: <a href="#">Table 112 [Link controller state encodings]</a>   |
| 15:14 | Reserved.                                                                                                                                      |
| 13:8  | <b>LcPrevState1: previous link state 1.</b> Read-only; updated-by-hardware. See: <a href="#">Table 112 [Link controller state encodings]</a> . |
| 7:6   | Reserved.                                                                                                                                      |
| 5:0   | <b>LcCurrentState: current link state.</b> Read-only; updated-by-hardware. See: <a href="#">Table 112 [Link controller state encodings]</a> .  |

**Table 112: Link controller state encodings**

| Bits | Description          | Bits | Description             | Bits | Description                 |
|------|----------------------|------|-------------------------|------|-----------------------------|
| 00h  | s_Detect_Quiet.      | 12h  | Rcv_L0_and_Tx_L0s.      | 24h  | s_Rcvd_Loopback.            |
| 01h  | s_Start_common_Mode. | 13h  | Rcv_L0_and_Tx_L0s_FTS.  | 25h  | s_Rcvd_Loopback_Idle.       |
| 02h  | s_Check_Common_Mode. | 14h  | Rcv_L0s_and_Tx_L0.      | 26h  | s_Rcvd_Reset_Idle.          |
| 03h  | s_Rcvr_Detect.       | 15h  | Rcv_L0s_and_Tx_L0_Idle. | 27h  | s_Rcvd_Disable_Entry.       |
| 04h  | s_No_Rcvr_Loop       | 16h  | Rcv_L0s_and_Tx_L0s.     | 28h  | s_Rcvd_Disable_Idle.        |
| 05h  | s_Poll_Quiet.        | 17h  | Rcv_L0s_and_Tx_L0s_FTS. | 29h  | s_Rcvd_Disable.             |
| 06h  | s_Poll_Active.       | 18h  | s_L1_Entry.             | 2Ah  | s_Detect_Idle.              |
| 07h  | s_Poll_Compliance.   | 19h  | s_L1_Idle.              | 2Bh  | s_L23_Wait.                 |
| 08h  | s_Poll_Config.       | 1Ah  | s_L1_Wait               | 2Ch  | Rcv_L0s_Skp_and_Tx_L0.      |
| 09h  | s_Config_Step1.      | 1Bh  | s_L1.                   | 2Dh  | Rcv_L0s_Skp_and_Tx_L0_Idle. |
| 0Ah  | s_Config_Step3.      | 1Ch  | s_L23_Stall.            | 2Eh  | Rcv_L0s_Skp_and_Tx_L0s.     |
| 0Bh  | s_Config_Step5.      | 1Dh  | s_L23_Entry.            | 2Fh  | Rcv_L0s_Skp_and_Tx_L0_FTS.  |
| 0Ch  | s_Config_Step2.      | 1Eh  | s_L23_Entry.            | 30h  | s_Config_Step2b.            |
| 0Dh  | s_Config_Step4.      | 1Fh  | s_L23_Ready.            | 31h  | s_Recovery_Speed.           |
| 0Eh  | s_Config_Step6.      | 20h  | s_Recovery_lock.        | 32h  | s_Poll_Compliance_Idle.     |

**Table 112: Link controller state encodings**

|     |                        |     |                    |         |                        |
|-----|------------------------|-----|--------------------|---------|------------------------|
| 0Fh | s_Config_Idle.         | 21h | s_Recovery_Config. | 33h     | s_Rcvd_Loopback_Speed. |
| 10h | Rcv_L0_and_Tx_L0.      | 22h | s_Recovery_Idle.   | 3Fh-34h | Reserved.              |
| 11h | Rcv_L0_and_Tx_L0_Idle. | 23h | s_Training_Bit.    |         |                        |

**D[4:2]F[5:1]xE4\_xB1 LC Control 2**

Reset: 8608\_0280h.

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:21 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 20    | <b>LcBlockElIdleInL0: block electrical idle in L0.</b> Read-write. BIOS: 1. 1=Prevent electrical idle from causing the receiver to transition from L0 to L0s.                                                                                                                                                                                                                                                                                                    |
| 19    | <b>LcDeassertRxEnInL0s: deassert RX_EN in L0s.</b> Read-write. 1=Turn off transmitters in L0s.                                                                                                                                                                                                                                                                                                                                                                   |
| 18:16 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 15:14 | <b>LcElecIdleMode: electrical idle mode.</b> Read-write. BIOS: 01b. Specifies the electrical idle entry and exit mode.<br><div style="margin-left: 20px;"> <u>Bits</u>      <u>definition</u><br/> 00b, 11b    GEN1: Entry and exit controlled by phy.<br/>               GEN2: Entry controlled by logic, exit controlled by phy.<br/> 01b         Entry controlled by logic, exit controlled by phy.<br/> 10b         Entry and exit controlled by phy. </div> |
| 13:0  | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                        |

**D[4:2]F[5:1]xE4\_xB5 LC Control 3**

Reset: 2850\_5020h.

| Bits | Description                                                                                                                                                                                                                                                                                                                                                              |
|------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31   | Reserved.                                                                                                                                                                                                                                                                                                                                                                |
| 30   | <b>LcGoToRecovery: go to recovery.</b> Read-write. 1=Force link in the L0 state to transition to the Recovery state.                                                                                                                                                                                                                                                     |
| 29:4 | Reserved.                                                                                                                                                                                                                                                                                                                                                                |
| 3    | <b>LcRcvdDeemphasis: received deemphasis.</b> Read-only; updated-by-hardware. Deemphasis advertised by the downstream device. 1=3.5dB. 0=6dB.                                                                                                                                                                                                                            |
| 2:1  | <b>LcSelectDeemphasisCntl: deemphasis control.</b> Read-write. Specifies the deemphasis used by the transmitter.<br><div style="margin-left: 20px;"> <u>Bits</u>      <u>Definition</u><br/> 00b         Use deemphasis from LcSelectDeemphasis.<br/> 01b         Use deemphasis advertised by the downstream device.<br/> 10b         6dB<br/> 11b         3.5dB </div> |
| 0    | <b>LcSelectDeemphasis: downstream deemphasis.</b> Read-write. Specifies the downstream deemphasis. 1=3.5dB. 0=6dB.                                                                                                                                                                                                                                                       |

**D[4:2]F[5:1]xE4\_xC0 LC Strap Override**

Reset: 0000\_0000h.

| Bits  | Description                                                                                                                                                          |
|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:16 | Reserved.                                                                                                                                                            |
| 15    | <b>StrapAutoRcSpeedNegotiationDis: autonomous speed negotiation disable strap override.</b> Read-write. 1=Disable autonomous root complex speed negotiation to Gen2. |
| 14    | Reserved.                                                                                                                                                            |
| 13    | <b>StrapForceCompliance: force compliance strap override.</b> Read-write.                                                                                            |
| 12:0  | Reserved.                                                                                                                                                            |

**D[4:2]F[5:1]xE4\_xC1 Root Port Miscellaneous Strap Override**

Reset: 0000\_0000h.

| Bits | Description                                                                          |
|------|--------------------------------------------------------------------------------------|
| 31:6 | Reserved.                                                                            |
| 5    | <b>StrapLtrSupported.</b> Read-write.                                                |
| 4:3  | <b>StrapObffSupported.</b> Read-write.                                               |
| 2    | <b>StrapExtendedFmtSupported: Extended Fmt Supported strap override.</b> Read-write. |
| 1    | <b>StrapE2EPrefixEn: E2E Prefix En strap override.</b> Read-write.                   |
| 0    | <b>StrapReverseLanes: reverse lanes strap override.</b> Read-write.                  |

**D[4:2]F[5:1]xE4\_xD0 Root Port ECC Skip OS Feature**

Reset: 0000\_0100h.

| Bits  | Description                                                                                                             |
|-------|-------------------------------------------------------------------------------------------------------------------------|
| 31:16 | <b>BchEccErrorStatus.</b> Read-write. Indicates that lane errors are above the specified threshold. (One bit per lane.) |
| 15:8  | <b>BchEccErrorThreshold.</b> Read-write. Error threshold.                                                               |
| 7:1   | Reserved.                                                                                                               |
| 0     | <b>StrapBchEccEn.</b> Read-write.                                                                                       |

**D[4:2]F[5:1]x100 Vendor Specific Enhanced Capability Register**

| Bits  | Description                                                                                                                           |
|-------|---------------------------------------------------------------------------------------------------------------------------------------|
| 31:20 | <b>NextPtr: next pointer.</b> Read-only. IF (D0F0xE4_x014[2:0]_00B0[StrapF0AerEn] == 1) THEN Reset: 150h.<br>ELSE Reset: 000h. ENDIF. |

|       |                                                          |
|-------|----------------------------------------------------------|
| 19:16 | <b>CapVer: capability version.</b> Read-only. Reset: 1h. |
| 15:0  | <b>CapID: capability ID.</b> Read-only. Reset: Bh.       |

#### D[4:2]F[5:1]x104 Vendor Specific Header Register

Reset: 0101\_0001h.

| Bits  | Description                                                                                                                                                                                    |
|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:20 | <b>VsecLen: vendor specific enhanced capability structure length.</b> Read-only. Defined the number of bytes of the entire vendor specific enhanced capability structure including the header. |
| 19:16 | <b>VsecRev: vendor specific enhanced capability version.</b> Read-only.                                                                                                                        |
| 15:0  | <b>VsecID: vendor specific enhanced capability ID.</b> Read-only.                                                                                                                              |

#### D[4:2]F[5:1]x108 Vendor Specific 1 Register

Reset: 0000\_0000h.

| Bits | Description                                                                    |
|------|--------------------------------------------------------------------------------|
| 31:0 | <b>Scratch: scratch.</b> Read-write. This field does not control any hardware. |

#### D[4:2]F[5:1]x10C Vendor Specific 2 Register

Reset: 0000\_0000h.

| Bits | Description                                                                    |
|------|--------------------------------------------------------------------------------|
| 31:0 | <b>Scratch: scratch.</b> Read-write. This field does not control any hardware. |

#### D[4:2]F[5:1]x128 Virtual Channel 0 Resource Status Register

Reset: 0002\_0000h.

| Bits  | Description                                                                                                                                                                                             |
|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:18 | Reserved.                                                                                                                                                                                               |
| 17    | <b>VcNegotiationPending: virtual channel negotiation pending.</b> Read-only; updated-by-hardware. 1=Virtual channel negotiation in progress. This bit must be 0 before the virtual channel can be used. |
| 16    | <b>PortArbTableStatus: port arbitration table status.</b> Read-only.                                                                                                                                    |
| 15:0  | Reserved.                                                                                                                                                                                               |

#### D[4:2]F[5:1]x150 Advanced Error Reporting Capability

| Bits  | Description                                                                                                                      |
|-------|----------------------------------------------------------------------------------------------------------------------------------|
| 31:20 | <b>NextPtr: next pointer.</b> Read-only.<br>IF (D0F0xE4_x014[2:0]_00B0[StrapF0AcEn] == 1) THEN 2A0h.<br>ELSE Reset: 000h. ENDIF. |

|       |                                                          |
|-------|----------------------------------------------------------|
| 19:16 | <b>CapVer: capability version.</b> Read-only. Reset: 2h. |
| 15:0  | <b>CapID: capability ID.</b> Read-only. Reset: 1h.       |

#### D[4:2]F[5:1]x154 Uncorrectable Error Status

Cold reset: 0000\_0000h.

| Bits  | Description                                                                                                                             |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------|
| 31:26 | Reserved.                                                                                                                               |
| 25    | <b>TlpPrefixStatus: TLP prefix blocked status.</b> Read; Write-1-to-clear.                                                              |
| 24    | <b>AtomicOpEgressBlockedTLPStatus: atomic op egress blocked TLP status.</b> Read; Write-1-to-clear.                                     |
| 23    | <b>McBlockedTLPStatus: MC blocked TLP status.</b> Read; Write-1-to-clear.                                                               |
| 22    | <b>UncorrInternalErrStatus: uncorrectable internal error status.</b> Read; Write-1-to-clear.                                            |
| 21    | <b>AcsViolationStatus: access control service status.</b> Read; Write-1-to-clear.                                                       |
| 20    | <b>UnsuppReqErrStatus: unsupported request error status.</b> Read; Write-1-to-clear. The header of the unsupported request is logged.   |
| 19    | <b>EcrcErrStatus: end-to-end CRC error status.</b> Read; Write-1-to-clear.                                                              |
| 18    | <b>MalTlpStatus: malformed TLP status.</b> Read; Write-1-to-clear. The header of the malformed TLP is logged.                           |
| 17    | <b>RcvOvflStatus: receiver overflow status.</b> Read-only.                                                                              |
| 16    | <b>UnexpCplStatus: unexpected completion timeout status.</b> Read; Write-1-to-clear. The header of the unexpected completion is logged. |
| 15    | <b>CplAbortErrStatus: completer abort error status.</b> Read; Write-1-to-clear.                                                         |
| 14    | <b>CplTimeoutStatus: completion timeout status.</b> Read; Write-1-to-clear.                                                             |
| 13    | <b>FcErrStatus: flow control error status.</b> Read-only.                                                                               |
| 12    | <b>PsnErrStatus: poisoned TLP status.</b> Read; Write-1-to-clear. The header of the poisoned transaction layer packet is logged.        |
| 11:6  | Reserved.                                                                                                                               |
| 5     | <b>SurprdnErrStatus: surprise down error status.</b> Read-only. 0=Detection and reporting of surprise down errors is not supported.     |
| 4     | <b>DlpErrStatus: data link protocol error status.</b> Read; Write-1-to-clear.                                                           |
| 3:0   | Reserved.                                                                                                                               |

#### D[4:2]F[5:1]x158 Uncorrectable Error Mask

Cold reset: 0000\_0000h.

| Bits  | Description                                                                        |
|-------|------------------------------------------------------------------------------------|
| 31:26 | Reserved.                                                                          |
| 25    | <b>TlpPrefixMask: TLP prefix blocked mask.</b> Read-only.                          |
| 24    | <b>AtomicOpEgressBlockedTLPMask: atomic op egress blocked TLP mask.</b> Read-only. |
| 23    | <b>McBlockedTLPMask: MC blocked TLP mask.</b> Read-only.                           |



|      |                                                                                                                       |
|------|-----------------------------------------------------------------------------------------------------------------------|
| 22   | <b>UncorrInternalErrMask: uncorrectable internal error mask.</b> Read-write.                                          |
| 21   | <b>AcsViolationMask: access control service mask.</b> Read-only. 1=ACS violation errors are not reported.             |
| 20   | <b>UnsuppReqErrMask: unsupported request error mask.</b> Read-write. 1=Unsupported request errors are not reported.   |
| 19   | <b>EcrcErrMask: end-to-end CRC error mask.</b> Read-write.                                                            |
| 18   | <b>MalTlpMask: malformed TLP mask.</b> Read-write. 1=Malformed TLP errors are not reported.                           |
| 17   | <b>RcvOvflMask: receiver overflow mask.</b> Read-only.                                                                |
| 16   | <b>UnexpCplMask: unexpected completion timeout mask.</b> Read-write. 1=Unexpected completion errors are not reported. |
| 15   | <b>CplAbortErrMask: completer abort error mask.</b> Read-write.                                                       |
| 14   | <b>CplTimeoutMask: completion timeout mask.</b> Read-write. 1=Completion timeout errors are not reported.             |
| 13   | <b>FcErrMask: flow control error mask.</b> Read-only.                                                                 |
| 12   | <b>PsnErrMask: poisoned TLP mask.</b> Read-write. 1=Poisoned TLP errors are not reported.                             |
| 11:6 | Reserved.                                                                                                             |
| 5    | <b>SurprdnErrMask: surprise down error mask.</b> Read-only.                                                           |
| 4    | <b>DlpErrMask: data link protocol error mask.</b> Read-write. 1=Data link protocol errors are not reported.           |
| 3:0  | Reserved.                                                                                                             |

#### D[4:2]F[5:1]x15C Uncorrectable Error Severity

Cold reset: 0006\_2030h.

| Bits  | Description                                                                                                    |
|-------|----------------------------------------------------------------------------------------------------------------|
| 31:26 | Reserved.                                                                                                      |
| 25    | <b>TlpPrefixSeverity: TLP prefix blocked severity.</b> Read-only.                                              |
| 24    | <b>AtomicOpEgressBlockedTLPSeverity: atomic op egress blocked TLP severity.</b> Read-only.                     |
| 23    | <b>McBlockedTLPSeverity: MC blocked TLP severity.</b> Read-only.                                               |
| 22    | <b>UncorrInternalErrSeverity: uncorrectable internal error severity.</b> Read-only.                            |
| 21    | <b>AcsViolationSeverity: access control service severity.</b> Read-only. 1=Fatal error. 0=Non-fatal error.     |
| 20    | <b>UnsuppReqErrSeverity: unsupported request error severity.</b> Read-write. 1=Fatal error. 0=Non-fatal error. |
| 19    | <b>EcrcErrSeverity: end-to-end CRC error severity.</b> Read-only.                                              |
| 18    | <b>MalTlpSeverity: malformed TLP severity.</b> Read-write. 1=Fatal error. 0=Non-fatal error.                   |
| 17    | <b>RcvOvflSeverity: receiver overflow severity.</b> Read-only.                                                 |
| 16    | <b>UnexpCplSeverity: unexpected completion timeout severity.</b> Read-write. 1=Fatal error. 0=Non-fatal error. |
| 15    | <b>CplAbortErrSeverity: completer abort error severity.</b> Read-only.                                         |
| 14    | <b>CplTimeoutSeverity: completion timeout severity.</b> Read-write. 1=Fatal error. 0=Non-fatal error.          |
| 13    | <b>FcErrSeverity: flow control error severity.</b> Read-only.                                                  |

|      |                                                                                                         |
|------|---------------------------------------------------------------------------------------------------------|
| 12   | <b>PsnErrSeverity: poisoned TLP severity.</b> Read-write. 1=Fatal error. 0=Non-fatal error.             |
| 11:6 | Reserved.                                                                                               |
| 5    | <b>SurprdnErrSeverity: surprise down error severity.</b> Read-only.                                     |
| 4    | <b>DlpErrSeverity: data link protocol error severity.</b> Read-write. 1=Fatal error. 0=Non-fatal error. |
| 3:0  | Reserved.                                                                                               |

**D[4:2]F[5:1]x160 Correctable Error Status**

Cold reset: 0000\_0000h.

| Bits  | Description                                                                                                                                                                               |
|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:16 | Reserved.                                                                                                                                                                                 |
| 15    | <b>HdrLogOvflStatus: header log overflow status.</b> Read-only.                                                                                                                           |
| 14    | <b>CorrIntErrStatus: corrected internal error status.</b> Read; Write-1-to-clear.                                                                                                         |
| 13    | <b>AdvisoryNonfatalErrStatus: advisory non-fatal error status.</b> Read; Write-1-to-clear. 1=A non-fatal unsupported request errors or a non-fatal unexpected completion errors occurred. |
| 12    | <b>ReplayTimerTimeoutStatus: replay timer timeout status.</b> Read; Write-1-to-clear.                                                                                                     |
| 11:9  | Reserved.                                                                                                                                                                                 |
| 8     | <b>ReplayNumRolloverStatus: replay.</b> Read; Write-1-to-clear. 1=The same transaction layer packet has been replayed three times and has caused the link to re-train.                    |
| 7     | <b>BadDlpStatus: bad data link layer packet status.</b> Read; Write-1-to-clear. 1=A link CRC error was detected.                                                                          |
| 6     | <b>BadTlpStatus: bad transaction layer packet status.</b> Read; Write-1-to-clear. 1=A bad non-duplicated sequence ID or a link CRC error was detected.                                    |
| 5:1   | Reserved.                                                                                                                                                                                 |
| 0     | <b>RcvErrStatus: receiver error status.</b> Read-only. 1=An 8B10B or disparity error was detected.                                                                                        |

**D[4:2]F[5:1]x164 Correctable Error Mask**

Cold reset: 0000\_6000h.

| Bits  | Description                                                                                         |
|-------|-----------------------------------------------------------------------------------------------------|
| 31:16 | Reserved.                                                                                           |
| 15    | <b>HdrLogOvflMask: header log overflow mask.</b> Read-only.                                         |
| 14    | <b>CorrIntErrMask: corrected internal error mask.</b> Read-write.                                   |
| 13    | <b>AdvisoryNonfatalErrMask: advisory non-fatal error mask.</b> Read-write. 1=Error is not reported. |
| 12    | <b>ReplayTimerTimeoutMask: replay timer timeout mask.</b> Read-write. 1=Error is not reported.      |
| 11:9  | Reserved.                                                                                           |
| 8     | <b>ReplayNumRolloverMask: replay.</b> Read-write. 1=Error is not reported.                          |
| 7     | <b>BadDlpMask: bad data link layer packet mask.</b> Read-write. 1=Error is not reported.            |
| 6     | <b>BadTlpMask: bad transaction layer packet mask.</b> Read-write. 1=Error is not reported.          |
| 5:1   | Reserved.                                                                                           |
| 0     | <b>RcvErrMask: receiver error mask.</b> Read-only. 1=Error is not reported.                         |

**D[4:2]F[5:1]x168 Advanced Error Control**

Cold reset: 0000\_0000h.

| Bits  | Description                                                                                                                                                                                            |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:12 | Reserved.                                                                                                                                                                                              |
| 11    | <b>TlpPrefixLogPresent</b> . Read-only. IF (D[4:2]F[5:1]x7C[EndEndTlpPrefixSupported]==0) THEN Reserved. ENDIF. 1=If FirstErrPtr is valid then the TLP Prefix Log register contains valid information. |
| 10    | <b>MultiHdrRecdEn</b> . Read-only. 1=Enables recording more than one error header.                                                                                                                     |
| 9     | <b>MultiHdrRecdCap</b> . Read-only. 1=Specifies that the function is capable of recording more than one error header.                                                                                  |
| 8     | <b>EcrcCheckEn: data link protocol error severity</b> . Read-write. 0=Specifies that End-to-end CRC generation is not supported.                                                                       |
| 7     | <b>EcrcCheckCap: data link protocol error severity</b> . Read-only. 0=Specifies that end-to-end CRC check is not supported.                                                                            |
| 6     | <b>EcrcGenEn: end-to-end CRC enable</b> . Read-only. 0=Specifies that End-to-end CRC generation is not supported.                                                                                      |
| 5     | <b>EcrcGenCap: end-to-end CRC capability</b> . Read-only. 0=Specifies that end-to-end CRC generation is not supported.                                                                                 |
| 4:0   | <b>FirstErrPtr: first error pointer</b> . Read-only. The First Error Pointer identifies the bit position of the first error reported in the Uncorrectable Error Status register.                       |

**D[4:2]F[5:1]x16C Header Log DW0**

Cold reset: 0000\_0000h.

| Bits | Description                                                                                                                                                                                           |
|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:0 | <b>TlpHdr: transaction layer packet header log</b> . Read-only. Contains the header for a transaction layer packet corresponding to a detected error. The upper byte represents byte 0 of the header. |

**D[4:2]F[5:1]x170 Header Log DW1**

Cold reset: 0000\_0000h.

| Bits | Description                                                                                                                                                                                           |
|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:0 | <b>TlpHdr: transaction layer packet header log</b> . Read-only. Contains the header for a transaction layer packet corresponding to a detected error. The upper byte represents byte 4 of the header. |

**D[4:2]F[5:1]x174 Header Log DW2**

Cold reset: 0000\_0000h.

| Bits | Description                                                                                                                                                                                           |
|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:0 | <b>TlpHdr: transaction layer packet header log</b> . Read-only. Contains the header for a transaction layer packet corresponding to a detected error. The upper byte represents byte 8 of the header. |

**D[4:2]F[5:1]x178 Header Log DW3**

Cold reset: 0000\_0000h.

| Bits | Description                                                                                                                                                                                           |
|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:0 | <b>TlpHdr: transaction layer packet header log.</b> Read-only. Contains the header for a transaction layer packet corresponding to a detected error. The upper byte represents byte 12 of the header. |

**D[4:2]F[5:1]x17C Root Error Command**

Reset: 0000\_0000h.

| Bits | Description                                                                                                                                                                                                           |
|------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:3 | Reserved.                                                                                                                                                                                                             |
| 2    | <b>FatalErrRepEn: fatal error reporting enable.</b> Read-write. 1=Enables the generation of an interrupt when a fatal error is reported by any of the devices in the hierarchy associated with this Root Port.        |
| 1    | <b>NonfatalErrRepEn: non-fatal error reporting enable.</b> Read-write. 1=Enables generation of an interrupt when a non-fatal error is reported by any of the devices in the hierarchy associated with this Root Port. |
| 0    | <b>CorrErrRepEn: correctable error reporting enable.</b> Read-write. 1=Enables generation of an interrupt when a correctable error is reported by any of the devices in the hierarchy associated with this Root Port. |

**D[4:2]F[5:1]x180 Root Error Status**

Cold reset: 0000\_0000h.

| Bits  | Description                                                                                                                                                                                     |
|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:27 | <b>AdvErrIntMsgNum: advanced error interrupt message number.</b> Read-only.                                                                                                                     |
| 26:7  | Reserved.                                                                                                                                                                                       |
| 6     | <b>NFatalErrMsgRcvd: fatal error message received.</b> Read; Write-1-to-clear. Set to 1 when one or more fatal uncorrectable error messages have been received.                                 |
| 5     | <b>NonFatalErrMsgRcvd: non-fatal error message received.</b> Read; Write-1-to-clear. Set to 1 when one or more non-fatal uncorrectable error messages have been received.                       |
| 4     | <b>FirstUncorrFatalRcvd: first uncorrectable fatal error message received.</b> Read; Write-1-to-clear. Set to 1 when the first uncorrectable error message received is for a fatal error.       |
| 3     | <b>MultErrFatalNonfatalRcvd: ERR_FATAL/NONFATAL message received.</b> Read; Write-1-to-clear. Set when either a fatal or a non-fatal error is received and ErrFatalNonfatalRcvd is already set. |
| 2     | <b>ErrFatalNonfatalRcvd: ERR_FATAL/NONFATAL message received.</b> Read; Write-1-to-clear. Set when either a fatal or a non-fatal error is received and this bit is not already set.             |
| 1     | <b>MultErrCorrRcvd: multiple ERR_COR messages received.</b> Read; Write-1-to-clear. Set when a correctable error message is received and ErrCorrRcvd is already set.                            |
| 0     | <b>ErrCorrRcvd: ERR_COR message received.</b> Read; Write-1-to-clear. Set when a correctable error message is received and this bit is not already set.                                         |

**D[4:2]F[5:1]x184 Error Source ID**

---

Cold reset: 0000\_0000h.

| Bits  | Description                                                                                                                                                                                                                                                     |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:16 | <b>ErrFatalNonfatalSrcID: ERR_FATAL/ERR_NONFATAL source identification.</b> Read-only. Loaded with the requestor ID indicated in the received ERR_FATAL or ERR_NONFATAL message when <a href="#">D[4:2]F[5:1]x180[ErrFatalNonfatalRcvd]</a> is not already set. |
| 15:0  | <b>ErrCorrSrcID: ERR_COR source identification.</b> Read-only. Loaded with the requestor ID indicated in the received ERR_COR message when <a href="#">D[4:2]F[5:1]x180[ErrCorrRcvd]</a> is not already set.                                                    |

### 3.9 Device 18h Function 0 Configuration Registers

See 3.1 [Register Descriptions and Mnemonics]. See 2.7 [Configuration Space].

#### D18F0x00 Device/Vendor ID

| Bits  | Description                                          |
|-------|------------------------------------------------------|
| 31:16 | <b>DeviceID:</b> device ID. Read-only. Value: 141Ah. |
| 15:0  | <b>VendorID:</b> vendor ID. Read-only. Value: 1022h. |

#### D18F0x04 Status/Command

| Bits  | Description                                                                                                         |
|-------|---------------------------------------------------------------------------------------------------------------------|
| 31:16 | <b>Status.</b> Read-only. Value: 0010h. Bit[20] is set to indicate the existence of a PCI-defined capability block. |
| 15:0  | <b>Command.</b> Read-only. Value: 0000h.                                                                            |

#### D18F0x08 Class Code/Revision ID

| Bits | Description                                                                                                           |
|------|-----------------------------------------------------------------------------------------------------------------------|
| 31:8 | <b>ClassCode.</b> Read-only. Value: 060000h. Provides the host bridge class code as defined in the PCI specification. |
| 7:0  | <b>RevID:</b> revision ID. Read-only. Value: 00h.                                                                     |

#### D18F0x0C Header Type

Read-only. Value: 0080\_0000h.

| Bits | Description                                                                                                                                                   |
|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:0 | <b>HeaderTypeReg.</b> These bits are fixed at their default values. The header type field indicates that there are multiple functions present in this device. |

#### D18F0x34 Capabilities Pointer

| Bits | Description                                                 |
|------|-------------------------------------------------------------|
| 31:8 | Reserved.                                                   |
| 7:0  | <b>CapPtr:</b> capabilities pointer. Read-only. Value: 00h. |

#### D18F0x[5C:40] Routing Table

Reset: 0004\_0201h.

**Table 113: Register Mapping** for D18F0x[5C:40]

| Register      | Function |
|---------------|----------|
| D18F0x40      | Node 0   |
| D18F0x[5C:44] | Reserved |

| Bits | Description |
|------|-------------|
| 31:0 | Reserved.   |

**D18F0x60 Node ID**

| Bits        | Description                                                                                                                                                                                                                                                                                                                                                                                                                                           |             |                    |     |        |         |                         |     |         |         |          |
|-------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|--------------------|-----|--------|---------|-------------------------|-----|---------|---------|----------|
| 31:21       | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                             |             |                    |     |        |         |                         |     |         |         |          |
| 20:16       | <b>CpuCnt[4:0]: CPU count bits[4:0].</b> Read-write. Reset: 0.<br>Specifies the number of cores to be enabled (the boot core plus those cores enabled through D18F0x1DC[CpuEn]). <table> <tr> <th><u>Bits</u></th><th><u>Description</u></th></tr> <tr> <td>00h</td><td>1 core</td></tr> <tr> <td>02h-01h</td><td>&lt;CpuCnt[4:0] + 1&gt; cores</td></tr> <tr> <td>03h</td><td>4 cores</td></tr> <tr> <td>1Fh-04h</td><td>Reserved</td></tr> </table> | <u>Bits</u> | <u>Description</u> | 00h | 1 core | 02h-01h | <CpuCnt[4:0] + 1> cores | 03h | 4 cores | 1Fh-04h | Reserved |
| <u>Bits</u> | <u>Description</u>                                                                                                                                                                                                                                                                                                                                                                                                                                    |             |                    |     |        |         |                         |     |         |         |          |
| 00h         | 1 core                                                                                                                                                                                                                                                                                                                                                                                                                                                |             |                    |     |        |         |                         |     |         |         |          |
| 02h-01h     | <CpuCnt[4:0] + 1> cores                                                                                                                                                                                                                                                                                                                                                                                                                               |             |                    |     |        |         |                         |     |         |         |          |
| 03h         | 4 cores                                                                                                                                                                                                                                                                                                                                                                                                                                               |             |                    |     |        |         |                         |     |         |         |          |
| 1Fh-04h     | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                              |             |                    |     |        |         |                         |     |         |         |          |
| 15:0        | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                             |             |                    |     |        |         |                         |     |         |         |          |

**D18F0x64 Unit ID**

Reset: 0000\_00E0h.

| Bits  | Description                                                                                                                        |
|-------|------------------------------------------------------------------------------------------------------------------------------------|
| 31:16 | Reserved.                                                                                                                          |
| 15:11 | Reserved.                                                                                                                          |
| 10:8  | Reserved.                                                                                                                          |
| 7:6   | <b>HbUnit: host bridge Unit ID.</b> Read-only. Specifies the coherent link Unit ID of the host bridge used by the coherent fabric. |
| 5:4   | <b>MctUnit: memory controller Unit ID.</b> Read-only. Specifies the coherent link Unit ID of the memory controller.                |
| 3:0   | Reserved.                                                                                                                          |

**D18F0x68 Link Transaction Control**

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |      |             |     |          |     |              |     |              |     |              |
|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|-----|----------|-----|--------------|-----|--------------|-----|--------------|
| 31    | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |      |             |     |          |     |              |     |              |     |              |
| 30:28 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |      |             |     |          |     |              |     |              |     |              |
| 27:26 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |      |             |     |          |     |              |     |              |     |              |
| 25    | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |      |             |     |          |     |              |     |              |     |              |
| 24    | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |      |             |     |          |     |              |     |              |     |              |
| 23    | <b>InstallStateS</b> : Read-write. Reset: 0. 1=Forces the default read block (RdBlk) install state to be shared instead of exclusive.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |      |             |     |          |     |              |     |              |     |              |
| 22:21 | <b>DsNpReqLmt: downstream non-posted request limit</b> . Read-write. Reset: 00b. BIOS: 10b. This specifies the maximum number of downstream non-posted requests issued by core(s) which may be outstanding on the IO links attached to this node at one time.<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>No limit</td></tr> <tr> <td>01b</td><td>limited to 1</td></tr> <tr> <td>10b</td><td>limited to 4</td></tr> <tr> <td>11b</td><td>limited to 8</td></tr> </table>                                                                                                                                   | Bits | Description | 00b | No limit | 01b | limited to 1 | 10b | limited to 4 | 11b | limited to 8 |
| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |      |             |     |          |     |              |     |              |     |              |
| 00b   | No limit                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |      |             |     |          |     |              |     |              |     |              |
| 01b   | limited to 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |      |             |     |          |     |              |     |              |     |              |
| 10b   | limited to 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |      |             |     |          |     |              |     |              |     |              |
| 11b   | limited to 8                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |      |             |     |          |     |              |     |              |     |              |
| 20    | <b>SeqIdSrcNodeEn: sequence ID source node enable</b> . Read-write. Reset: 0. 1=The source node ID of requests is provided in the SeqID field of the corresponding downstream IO link request packets. This may be useful for debug applications, in order to match downstream packets with their originating node. For normal operation, this bit should be cleared. Correct ordering of requests between different nodes is not ensured when this bit is set. Semaphore sharing between differing nodes may not work properly in systems which are capable of processing IO requests with differing non-zero SeqIds out of request order. |      |             |     |          |     |              |     |              |     |              |
| 19    | <b>ApicExtSpur: APIC extended spurious vector enable</b> . Read-write. Reset: 0. This enables the extended APIC spurious vector functionality; it affects <a href="#">APICF0[Vector]</a> . 0=The lower 4 bits of the spurious vector are read-only 1111b. 1=The lower 4 bits of the spurious vector are writable.                                                                                                                                                                                                                                                                                                                           |      |             |     |          |     |              |     |              |     |              |
| 18    | <b>ApicExtId: APIC extended ID enable</b> . Read-write. Reset: 0. Enables the extended APIC ID functionality. 0=APIC ID is 4 bits. 1=APIC ID is 8 bits.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |      |             |     |          |     |              |     |              |     |              |
| 17    | <b>ApicExtBrdCst: APIC extended broadcast enable</b> . Read-write. Reset: 0. Enables the extended APIC broadcast functionality. 0=APIC broadcast is 0Fh. 1=APIC broadcast is FFh. If ApicExtBrdCst=1 then software must assert ApicExtId.                                                                                                                                                                                                                                                                                                                                                                                                   |      |             |     |          |     |              |     |              |     |              |
| 16    | <b>LintEn: local interrupt conversion enable</b> . Read-write. Reset: 0. 1=Enables the conversion of broadcast ExtInt and NMI interrupt requests to LINT0 and LINT1 local interrupts, respectively, before delivering to the local APIC. This conversion only takes place if the local APIC is hardware enabled. LINT0 and LINT1 are controlled by <a href="#">APIC3[60:50]</a> . 0=ExtInt/NMI interrupts delivered unchanged.                                                                                                                                                                                                              |      |             |     |          |     |              |     |              |     |              |
| 15    | <b>LimitCldtCfg: limit coherent link configuration space range</b> . Read-write. Reset: 0. BIOS: 1.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |      |             |     |          |     |              |     |              |     |              |
| 14:13 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |      |             |     |          |     |              |     |              |     |              |



|    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 12 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 11 | <b>RespPassPW: response PassPW.</b> Read-write. Reset: 0. BIOS: 1. 1=The PassPW bit in all downstream link responses is set, regardless of the originating request packet. This technically breaks the PCI ordering rules but it is not expected to be an issue in the downstream direction. Setting this bit improves the latency of upstream requests by allowing the downstream responses to pass posted writes. 0=The PassPW bit in downstream responses is based on the RespPassPW bit of the original request. |
| 10 | <b>DisFillP: disable fill probe.</b> Read-write. Reset: 0. Controls probes for core-generated fills. 0=Probes issued for cache fills. 1=Probes not issued for cache fills. BIOS: 0. BIOS may set if single core.                                                                                                                                                                                                                                                                                                     |
| 9  | <b>DisRmtPMemC: disable remote probe memory cancel.</b> Read-write. Reset: 0. 1=Only probed caches on the same node as the target memory controller may generate MemCancel coherent link packets. MemCancels are used to attempt to save DRAM and/or link bandwidth associated with the transfer of stale DRAM data. 0=Probes hitting dirty blocks may generate MemCancel packets, regardless of the location of the probed cache.                                                                                   |
| 8  | <b>DisPMemC: disable probe memory cancel.</b> Read-write. Reset: 0. Controls generation of MemCancel coherent link packets. MemCancels are used to attempt to save DRAM and/or coherent link bandwidth associated with the transfer of stale DRAM data. 0=Probes hitting dirty blocks of the core cache may generate MemCancel packets. 1=Probes may not generate MemCancel packets.                                                                                                                                 |
| 7  | <b>CPURdRspPassPW: CPU read response PassPW.</b> Read-write. Reset: 0. 1=Read responses to core-generated reads are allowed to pass posted writes. 0=core responses do not pass posted writes. This bit is not expected to be set. This bit may only be set during the boot process.                                                                                                                                                                                                                                 |
| 6  | <b>CPUReqPassPW: CPU request PassPW.</b> Read-write. Reset: 0. 1=Core-generated requests are allowed to pass posted writes. 0=Core requests do not pass posted writes. This bit is not expected to be set. This bit may only be set during the boot process.                                                                                                                                                                                                                                                         |
| 5  | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 4  | <b>DisMTS: disable memory controller target start.</b> Read-write. Reset: 0. BIOS: 1. 1=Disables use of TgtStart. TgtStart is used to improve scheduling of back-to-back ordered transactions by indicating when the first transaction is received and ordered at the memory controller.                                                                                                                                                                                                                             |
| 3  | <b>DisWrDwP: disable write doubleword probes.</b> Read-write. Reset: 0. BIOS: 0. 1=Disables generation of probes for core-generated, WrSized doubleword commands.                                                                                                                                                                                                                                                                                                                                                    |
| 2  | <b>DisWrBP: disable write byte probes.</b> Read-write. Reset: 0. BIOS: 0. 1=Disables generation of probes for core-generated, WrSized byte commands.                                                                                                                                                                                                                                                                                                                                                                 |
| 1  | <b>DisRdDwP: disable read doubleword probe.</b> Read-write. Reset: 0. BIOS: 0. 1=Disables generation of probes for core-generated, RdSized doubleword commands.                                                                                                                                                                                                                                                                                                                                                      |
| 0  | <b>DisRdBP: disable read byte probe.</b> Read-write. Reset: 0. BIOS: 0. 1=Disables generation of probes for core-generated, RdSized byte commands.                                                                                                                                                                                                                                                                                                                                                                   |

#### D18F0x6C Link Initialization Control

| Bits | Description |
|------|-------------|
| 31   | Reserved.   |

|       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 30    | <b>RlsLnkFullTokCntImm: release upstream full token count immediately.</b> Read-write. Cold reset: 0b. BIOS: 1 after buffer counts have been programmed. 1=Apply buffer counts programmed in <a href="#">D18F0x[F0,D0,B0,90]</a> and <a href="#">D18F0x[F4,D4,B4,94]</a> immediately without requiring warm reset. Once this bit is set, additional changes to the buffer counts only take effect upon warm reset.                                                                                                                                                                                                               |
| 29    | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 28    | <b>RlsIntFullTokCntImm: release internal full token count immediately.</b> Read-write. Cold reset: 0b. BIOS: 1 after buffer counts have been programmed. 1=Apply buffer counts programmed in <a href="#">D18F3x6C</a> , <a href="#">D18F3x70</a> , <a href="#">D18F3x74</a> , <a href="#">D18F3x78</a> , <a href="#">D18F3x7C</a> , <a href="#">D18F3x140</a> , <a href="#">D18F3x144</a> , <a href="#">D18F3x1[54:48]</a> , <a href="#">D18F3x17C</a> , and <a href="#">D18F3x1A0</a> immediately without requiring warm reset. Once this bit is set, additional changes to the buffer counts only take effect upon warm reset. |
| 27    | <b>ApplyIsocModeEnNow.</b> Read-write. Cold reset: 0b. BIOS: 1 after RlsLnkFullTokCntImm and RlsIntFullTokCntImm have been set. 1=Apply the programmed value in <a href="#">D18F0x[E4,C4,A4,84][Iso-cEn]</a> immediately without requiring warm reset. This bit may only be set if RlsLnkFullTokCntImm and RlsIntFullTokCntImm are set and isochronous buffers have been allocated. IF (ApplyIsocModeEnNow) THEN ( <a href="#">D18F3x1[54:48][IsocPreqTok0]</a> > 0).                                                                                                                                                            |
| 26:24 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 23    | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 22:21 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 20    | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 19:16 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 15:12 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 11    | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 10:9  | <b>BiosRstDet[2:1]: BIOS reset detect bits[2:1].</b> See: BiosRstDet[0].                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 8     | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 7     | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 6     | <b>InitDet: CPU initialization command detect.</b> Read-write. Reset: 0. This bit may be used by software to distinguish between an INIT and a warm/cold reset by setting it to a 1 before an initialization event is generated. This bit is cleared by RESET_L but not by an INIT command.                                                                                                                                                                                                                                                                                                                                      |
| 5     | <b>BiosRstDet[0]: BIOS reset detect bit[0].</b> Read-write. Cold reset: 0. BiosRstDet[2:0] = {BiosRstDet[2:1], BiosRstDet[0]}. May be used to distinguish between a reset event generated by the BIOS versus a reset event generated for any other reason by setting one or more of the bits to a 1 before initiating a BIOS-generated reset event.                                                                                                                                                                                                                                                                              |
| 4     | <b>ColdRstDet: cold reset detect.</b> Read-write. Cold reset: 0. This bit may be used to distinguish between a cold versus a warm reset event by setting the bit to a 1 before an initialization event is generated.                                                                                                                                                                                                                                                                                                                                                                                                             |
| 3:2   | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |

|   |                                                                              |
|---|------------------------------------------------------------------------------|
| 1 | Reserved.                                                                    |
| 0 | <b>RouteTblDis: routing table disable.</b> Read-write.<br>Reset: 1. BIOS: 0. |

### D18F0x[E4,C4,A4,84] Link Control

Table 114: Register Mapping for D18F0x[E4,C4,A4,84]

| Register      | Function       |
|---------------|----------------|
| D18F0x84      | ONION Link     |
| D18F0xA4      | ONIONPlus Link |
| D18F0x[E4,C4] | Reserved       |

This register is derived from the link control register defined in the link specification.

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:16 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 15    | <b>Addr64BitEn: 64-bit address packet enable.</b> Read-write. Cold reset: 0000b. 1=Requests to addresses greater than FF_FFFF_FFFFh are supported by this IO link. 0=Requests to addresses greater than FF_FFFF_FFFFh are master aborted as if the end of chain was reached. BIOS is required to ensure that the link-specification-defined “64 Bit Address Feature” bit in the device on the other side of the link is set prior to setting this bit. For coherent links, this bit is unused. <a href="#">D18F0x68[CHtExtAddrEn]</a> is required to be set if this bit is set for any IO link. The link specification indicates that this bit is cleared by a warm reset; therefore this bit may be in a different state than an IO device on the other side of the link after a warm reset; care should be taken by BIOS to place devices on both sides of the link in the same state after a warm reset, before any packets to the high-order addresses enabled by this bit are generated. |
| 14:13 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 12    | <b>IsocEn: isochronous flow-control mode enable.</b> Read-write. Cold reset: 0b. BIOS: 1 if the link is an ONION Link. This bit is set to place the link into isochronous flow-control mode (IFCM), as defined by the link specification. 1=IFCM. 0=Normal flow-control mode. See <a href="#">D18F0x6C[ApplyIsocModeEnNow]</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| 11:6  | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 5     | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 4     | <b>LinkFail: link failure.</b> Read; set-by-hardware; write-1-to-clear. Cold reset: 0. This bit is set high by the hardware if a sync flood is received by the link. See <a href="#">2.15.1.9.1 [Common Diagnosis Information]</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 3:0   | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |

### D18F0x[EC,CC,AC,8C] Link Feature Capability

This register is derived from the link feature capability register defined in the link specification. Unless otherwise specified: 0=The feature is not supported; 1=The feature is supported.

Table 115: Register Mapping for D18F0x[EC,CC,AC,8C]

| Register      | Function       |
|---------------|----------------|
| D18F0x8C      | ONION Link     |
| D18F0xAC      | ONIONPlus Link |
| D18F0x[EC,CC] | Reserved       |

| Bits | Description                                                                                                                                                                                                                                             |
|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:6 | Reserved.                                                                                                                                                                                                                                               |
| 5    | <b>UnitIdReOrderDis: UnitID reorder disable.</b> Read-write. Reset: 0. 1=Upstream reordering for different UnitIDs is not supported; i.e., all upstream packets are ordered as if they have the same UnitID. 0=Reordering based on UnitID is supported. |
| 4    | Reserved. Reset: 1.                                                                                                                                                                                                                                     |
| 3:2  | Reserved.                                                                                                                                                                                                                                               |
| 1    | Reserved. Reset: 1.                                                                                                                                                                                                                                     |
| 0    | Reserved. Reset: 1.                                                                                                                                                                                                                                     |

**D18F0x[F0,D0,B0,90] Link Base Channel Buffer Count**

Read-write; Reset-applied.

Table 116: Register Mapping for D18F0x[F0,D0,B0,90]

| Register      | Function       |
|---------------|----------------|
| D18F0x90      | ONION Link     |
| D18F0xB0      | ONIONPlus Link |
| D18F0x[F0,D0] | Reserved       |

D18F0x[F0,D0,B0,90] and D18F0x[F4,D4,B4,94] specify the *hard-allocated* link flow-control buffer counts in each virtual channel available to the transmitter at the other end of the link; it also provides the *free buffers* that may be used by any of the virtual channels, as needed. Base channel buffers are specified in D18F0x[F0,D0,B0,90]; isochronous buffer counts (if in IFCM) are specified in D18F0x[F4,D4,B4,94]. For all fields that specify buffer counts in D18F0x[F0,D0,B0,90] and D18F0x[F4,D4,B4,94], if the link is ganged, then the number of buffers allocated is 2 times the value of the field; If the link is unganged, then the number of buffers allocated is the value of the field.

The cold or warm reset value is determined by whether the link initializes, whether the link is IO/coherent, whether the link is ganged/unganged, and whether the settings are locked by LockBc. Out of cold reset, the processor allocates a minimal number of buffers that is smaller than the default values in the register. BIOS must use D18F0x6C[RlsLnkFullTokCntImm] for the values in the register to take effect. This is necessary even if the values are unchanged from the default values.

The hard-allocated buffer counts are transmitted to the device at the other end of the link in buffer release messages after link initialization. The remaining buffers are held in the free list (specified by FreeData and FreeCmd) used to optimize buffer usage. When a transaction is received, if a free-list buffer is available, it is used for storage instead of one of the hard allocated buffers; as a result, a buffer release (for one of the hard allocated buffers used by the incoming request) can be immediately sent back to the device at the other end of

the link without waiting for the transaction to be routed beyond the flow-control buffers.

**Table 117: Link Buffer Definitions**

| Term            | Definition                                        |
|-----------------|---------------------------------------------------|
| <b>LpbSize</b>  | Link Packet Command Buffer size.<br>LpbSize = 48. |
| <b>LpbdSize</b> | Link Packet Data Buffer size.<br>LpbdSize = 32.   |
| <b>LcsSize</b>  | Link Command Scheduler size.<br>LcsSize = 48.     |

Buffer allocation rules:

- The total number of command buffers allocated in the base and isochronous registers of a link cannot exceed **LpbSize**:
  - $(D18F0x[B0,90][NpReqCmd] + D18F0x[B0,90][PReq] + D18F0x[B0,90][RspCmd] + D18F0x[B0,90][ProbeCmd] + D18F0x[B0,90][FreeCmd] + D18F0x[B4,94][IsocNpReqCmd] + D18F0x[B4,94][IsocPReq] + D18F0x[B4,94][IsocRspCmd]) \leq LpbSize$ .
- The total number of data buffers allocated in the base and isochronous registers of a link cannot exceed **LpbdSize**:
  - $(D18F0x[B0,90][NpReqData] + D18F0x[B0,90][RspData] + D18F0x[B0,90][PReq] + D18F0x[B0,90][FreeData] + D18F0x[B4,94][IsocPReq] + D18F0x[B4,94][IsocNpReqData] + D18F0x[B4,94][IsocRspData]) \leq LpbdSize$ .
- The total number of hard allocated command buffers cannot exceed **LcsSize**.
  - $(D18F0x[B0,90][ProbeCmd] + D18F0x[B0,90][RspCmd] + D18F0x[B0,90][PReq] + D18F0x[B0,90][NpReqCmd] + D18F0x[B4,94][IsocRspCmd] + D18F0x[B4,94][IsocPReq] + D18F0x[B4,94][IsocNpReqCmd]) \leq LcsSize$ .
- BIOS must set up non-zero counts (and adjust the base channel counts accordingly) prior to enabling **IFCM**.
- If an **IOMMU** is present in the system, **D18F0x[F4,D4,B4,94][IsocNpReqCmd]** must be non-zero for all enabled links.
- If an **IOMMU** is present in the system, **D18F0x[E4,C4,A4,84][IsocEn]** must be enabled for the ONION link.

| Bits | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31   | <b>LockBc: lock buffer count register.</b><br>Cold reset: 0.<br>BIOS: 1.<br>1=The buffer count registers, <b>D18F0x[F0,D0,B0,90]</b> and <b>D18F0x[F4,D4,B4,94]</b> are locked such that warm resets do not place the registers back to their default value. Setting this bit does not prevent the buffer counts from being updated after a warm reset based on the value of the buffer counts before the warm reset. 0=Upon warm reset, the buffer count registers return to their default value after the link initializes regardless of the value before the warm reset. |
| 30   | <b>PReq[3]: posted request command and data buffer count [3].</b><br>IF (LockBc) THEN Cold reset: 0. ELSE Reset: 0. ENDIF.<br>BIOS: IF (REG==D18F0x90) THEN 1 ELSE 0 ENDIF.<br>See: PReq[2:0].                                                                                                                                                                                                                                                                                                                                                                              |

|       |                                                                                                                                                                                                                                                                                                            |
|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 29:28 | <b>NpReqData[3:2]: non-posted request data buffer count [3:2].</b><br>IF (LockBc) THEN Cold reset: 00b. ELSE THEN Reset: 00b. ENDIF.<br>BIOS: IF (REG==D18F0x90) THEN 00b ELSE 11b ENDIF.<br>See: NpReqData[1:0].                                                                                          |
| 27:25 | <b>FreeData: free data buffer count.</b><br>IF (D18F0x[F0,D0,B0,90][LockBc]) THEN Cold reset: 0. ELSE THEN Reset: 0. ENDIF.<br>BIOS: IF (REG==D18F0x90) THEN 3 ELSE 1 ENDIF.                                                                                                                               |
| 24:20 | <b>FreeCmd: free command buffer count.</b><br>IF (D18F0x[F0,D0,B0,90][LockBc]) THEN Cold reset: 0. ELSE THEN Reset: 0. ENDIF.<br>BIOS: IF (REG==D18F0x90) THEN 01h ELSE 00h ENDIF.                                                                                                                         |
| 19:18 | <b>RspData: response data buffer count.</b><br>IF (LockBc) THEN Cold reset: 1. ELSE THEN Reset: 1. ENDIF.<br>BIOS: IF (REG==D18F0x90) THEN 1 ELSE 0 ENDIF.                                                                                                                                                 |
| 17:16 | <b>NpReqData[1:0]: non-posted request data buffer count [1:0].</b><br>NpReqData[3:0] = {NpReqData[3:2], NpReqData[1:0]}.<br>IF (LockBc) THEN Cold reset: 01b. ELSE THEN Reset: 01b. ENDIF.<br>BIOS: IF (REG==D18F0x90) THEN 01b ELSE 11b ENDIF.                                                            |
| 15:12 | <b>ProbeCmd: probe command buffer count.</b><br>IF (LockBc) THEN Cold reset: 0h. ELSE THEN Reset: 0h. ENDIF.<br>BIOS: 0h.                                                                                                                                                                                  |
| 11:8  | <b>RspCmd: response command buffer count.</b><br>IF (LockBc) THEN Cold reset: 1h. ELSE THEN Reset: 1h. ENDIF.<br>BIOS: IF (REG==D18F0x90) THEN 2h ELSE 0h ENDIF.                                                                                                                                           |
| 7:5   | <b>PReq[2:0]: posted request command and data buffer count [2:0].</b><br>PReq[3:0] = {PReq[3], PReq[2:0]}. Specifies the number of posted command and posted data buffers allocated.<br>IF (LockBc) THEN Cold reset: 110b. ELSE Reset: 110b. ENDIF.<br>BIOS: IF (REG==D18F0x90) THEN 010b ELSE 000b ENDIF. |
| 4:0   | <b>NpReqCmd: non-posted request command buffer count.</b><br>IF (LockBc) THEN Cold reset: 09h. ELSE THEN Reset: 09h. ENDIF.<br>BIOS: IF (REG==D18F0x90) THEN 0Ah ELSE 18h ENDIF.                                                                                                                           |

#### **D18F0x[F4,D4,B4,94] Link Isochronous Channel Buffer Count**

Read-write; Reset-applied. See [D18F0x\[F0,D0,B0,90\]](#).

Table 118: [Register Mapping](#) for [D18F0x\[F4,D4,B4,94\]](#)

| Register | Function |
|----------|----------|
|----------|----------|

Table 118: Register Mapping for D18F0x[F4,D4,B4,94]

|               |                |
|---------------|----------------|
| D18F0x94      | ONION Link     |
| D18F0xB4      | ONIONPlus Link |
| D18F0x[F4,D4] | Reserved       |

| Bits  | Description                                                                                                                                                                                                                                                                                                                                      |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:29 | Reserved.                                                                                                                                                                                                                                                                                                                                        |
| 28:27 | <b>IsocRspData: isochronous response data buffer count.</b> IF (D18F0x[F0,D0,B0,90][LockBc]) THEN Cold reset: 0. ELSE THEN Reset: 0. ENDIF. BIOS: 0.                                                                                                                                                                                             |
| 26:25 | <b>IsocNpReqData: isochronous non-posted request data buffer count.</b> IF (D18F0x[F0,D0,B0,90][LockBc]) THEN Cold reset: 0. ELSE THEN Reset: 0. ENDIF. BIOS: IF (REG==D18F0x94) THEN 1 ELSE 0 ENDIF.                                                                                                                                            |
| 24:22 | <b>IsocRspCmd: isochronous response command buffer count.</b> IF (D18F0x[F0,D0,B0,90][LockBc]) THEN Cold reset: 0. ELSE THEN Reset: 0. ENDIF. BIOS: 0.                                                                                                                                                                                           |
| 21:19 | <b>IsocPReq: isochronous posted request command and data buffer count.</b> IF (D18F0x[F0,D0,B0,90][LockBc]) THEN Cold reset: 0. ELSE THEN Reset: 0. ENDIF. This specifies the number of isochronous posted command and posted data buffers allocated. BIOS: 0.                                                                                   |
| 18:16 | <b>IsocNpReqCmd: isochronous non-posted request command buffer count.</b> IF (D18F0x[F0,D0,B0,90][LockBc]) THEN Cold reset: 0. ELSE THEN Reset: 0. ENDIF. BIOS: IF (REG==D18F0x94) THEN 1 ELSE 0 ENDIF.                                                                                                                                          |
| 15:8  | <b>SecBusNum: secondary bus number.</b> Reset: 0. Specifies the configuration-space bus number of the IO link. When configured as a coherent link, this register has no meaning. This field should match the corresponding D18F1x[1DC:1D0,EC:E0][BusNumBase], unless D18F1x[1DC:1D0,EC:E0][DevCmpEn]=1, in which case this field should be 00h). |
| 7:0   | Reserved.                                                                                                                                                                                                                                                                                                                                        |

**D18F0x[F8,D8,B8,98] Link Type**

Table 119: Register Mapping for D18F0x[F8,D8,B8,98]

| Register      | Function       |
|---------------|----------------|
| D18F0x98      | ONION Link     |
| D18F0xB8      | ONIONPlus Link |
| D18F0x[F8,D8] | Reserved       |

| Bits | Description                              |
|------|------------------------------------------|
| 31:6 | Reserved.                                |
| 5    | <b>PciEligible.</b> Read-only. Reset: 1. |
| 4:3  | Reserved.                                |
| 2    | Reserved.                                |

|   |           |
|---|-----------|
| 1 | Reserved. |
| 0 | Reserved. |

### D18F0x[11C,118,114,110] Link Clumping Enable

Reset: 0000\_0000h. **D18F0x[11C,118,114,110]** are associated with the whole link if it is ganged or sublink 0 if it is unganged; If the node does not support a link, then the corresponding register addresses become reserved.

Table 120: Register Mapping for **D18F0x[11C,118,114,110]**

| Register      | Function       |
|---------------|----------------|
| D18F0x110     | ONION Link     |
| D18F0x114     | ONIONPlus Link |
| D18F0x11[C:8] | Reserved       |

These registers specify how UnitIDs of upstream non-posted requests may be clumped per the link specification. The processor does not clump requests that it generates in the downstream direction.

| Bits | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:1 | <b>ClumpEn.</b> Read-write. Each bit of this register corresponds to a link UnitID number. E.g., bit 2 corresponds to UnitID 02h, etc. 1=The specified UnitID is ordered in the same group as the specified UnitID - 1. For example if this register is programmed to 0000_00C0h, then UnitIDs 7h, 6h, and 5h are all ordered as if they are part of the same UnitID. This is used to allow more than 32 tags to be assigned to a single stream for the purposes of ordering. |
| 0    | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |

### D18F0x150 Link Global Retry Control

Cold reset: 0000\_0000h.

| Bits | Description |
|------|-------------|
| 31:0 | Reserved.   |

### D18F0x168 Extended Link Transaction Control

Read-write.

| Bits  | Description                                    |
|-------|------------------------------------------------|
| 31:21 | Reserved.                                      |
| 20    | <b>XcsSecPickerDstNcHt.</b> Reset: 0. BIOS: 1. |
| 19    | Reserved.                                      |
| 18    | Reserved.                                      |
| 17:15 | Reserved.                                      |
| 14:12 | Reserved.                                      |
| 11:0  | Reserved.                                      |



**D18F0x16C Link Global Extended Control**

Reset: 0000\_0000h.

| Bits | Description |
|------|-------------|
| 31:0 | Reserved.   |

**D18F0x[18C:170] Link Extended Control**

These registers provide control for each link. They are mapped to the links as follows:

Table 121: [Register Mapping](#) for D18F0x[18C:170]

| Register       | Function       |
|----------------|----------------|
| D18F0x170      | ONION Link     |
| D18F0x174      | ONIONPlus Link |
| D18F0x1[8C:78] | Reserved       |

Reset: 0000\_0001h.

| Bits | Description |
|------|-------------|
| 31:0 | Reserved.   |

**D18F0x1A0 Link Initialization Status**Table 122: **Onion Definitions**

| Term             | Definition                                                      |
|------------------|-----------------------------------------------------------------|
| <b>OnionPlus</b> | OnionPlus link detected. OnionPlus = (D18F0x1A0[OnionPlusCap]). |

| Bits    | Description                                                                                                                                                                                                                                                                                                                                                                                         |      |             |     |                                                             |         |          |       |                                                         |
|---------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|-----|-------------------------------------------------------------|---------|----------|-------|---------------------------------------------------------|
| 31      | <b>InitStatusValid: initialization status valid.</b> Read-only; Updated-by-hardware. Reset: 0. 1=Indicates that the rest of the information in this register is valid for all links; each link is either not connected or the initialization is complete.                                                                                                                                           |      |             |     |                                                             |         |          |       |                                                         |
| 30:28   | Reserved.                                                                                                                                                                                                                                                                                                                                                                                           |      |             |     |                                                             |         |          |       |                                                         |
| 27:24   | <b>OnionPlusCap.</b> Read-only; Updated-by-hardware. Reset: 0h. 1=OnionPlus capable link detected.<br><table> <tr> <th>Bit</th><th>Description</th></tr> <tr> <td>[0]</td><td>Link 0</td></tr> <tr> <td>[1]</td><td>Link 1</td></tr> <tr> <td>[2:3]</td><td>Reserved</td></tr> </table>                                                                                                             | Bit  | Description | [0] | Link 0                                                      | [1]     | Link 1   | [2:3] | Reserved                                                |
| Bit     | Description                                                                                                                                                                                                                                                                                                                                                                                         |      |             |     |                                                             |         |          |       |                                                         |
| [0]     | Link 0                                                                                                                                                                                                                                                                                                                                                                                              |      |             |     |                                                             |         |          |       |                                                         |
| [1]     | Link 1                                                                                                                                                                                                                                                                                                                                                                                              |      |             |     |                                                             |         |          |       |                                                         |
| [2:3]   | Reserved                                                                                                                                                                                                                                                                                                                                                                                            |      |             |     |                                                             |         |          |       |                                                         |
| 23:4    | Reserved.                                                                                                                                                                                                                                                                                                                                                                                           |      |             |     |                                                             |         |          |       |                                                         |
| 3:2     | <b>InitComplete1: initialization complete for link 1.</b> See: InitComplete0.                                                                                                                                                                                                                                                                                                                       |      |             |     |                                                             |         |          |       |                                                         |
| 1:0     | <b>InitComplete0: initialization complete for link 0.</b> Read-only; Updated-by-hardware. Reset: 00b.<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>Internal northbridge link has not completed initialization.</td></tr> <tr> <td>10b-01b</td><td>Reserved</td></tr> <tr> <td>11b</td><td>Internal northbridge link has completed initialization.</td></tr> </table> | Bits | Description | 00b | Internal northbridge link has not completed initialization. | 10b-01b | Reserved | 11b   | Internal northbridge link has completed initialization. |
| Bits    | Description                                                                                                                                                                                                                                                                                                                                                                                         |      |             |     |                                                             |         |          |       |                                                         |
| 00b     | Internal northbridge link has not completed initialization.                                                                                                                                                                                                                                                                                                                                         |      |             |     |                                                             |         |          |       |                                                         |
| 10b-01b | Reserved                                                                                                                                                                                                                                                                                                                                                                                            |      |             |     |                                                             |         |          |       |                                                         |
| 11b     | Internal northbridge link has completed initialization.                                                                                                                                                                                                                                                                                                                                             |      |             |     |                                                             |         |          |       |                                                         |

**D18F0x1DC Core Enable**

Reset: 0000\_0000h.

| Bits       | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |            |                    |     |               |       |                     |     |               |        |          |
|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|--------------------|-----|---------------|-------|---------------------|-----|---------------|--------|----------|
| 31:16      | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |            |                    |     |               |       |                     |     |               |        |          |
| 15:1       | <p><b>CpuEn: core enable.</b> Read-write. This field is used to enable each of the cores after a reset. 1=Enable the core to start fetching and executing code from the boot vector. The most significant bit N is indicated by CpuCoreNum, as defined in section 2.4.4 [Processor Cores and Downcoring]. All bits greater than N are reserved.</p> <table> <tr> <th><u>Bit</u></th><th><u>Description</u></th></tr> <tr> <td>[0]</td><td>Core 1 enable</td></tr> <tr> <td>[5:1]</td><td>Core &lt;BIT+1&gt; enable</td></tr> <tr> <td>[6]</td><td>Core 7 enable</td></tr> <tr> <td>[15:3]</td><td>Reserved</td></tr> </table> | <u>Bit</u> | <u>Description</u> | [0] | Core 1 enable | [5:1] | Core <BIT+1> enable | [6] | Core 7 enable | [15:3] | Reserved |
| <u>Bit</u> | <u>Description</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |            |                    |     |               |       |                     |     |               |        |          |
| [0]        | Core 1 enable                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |            |                    |     |               |       |                     |     |               |        |          |
| [5:1]      | Core <BIT+1> enable                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |            |                    |     |               |       |                     |     |               |        |          |
| [6]        | Core 7 enable                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |            |                    |     |               |       |                     |     |               |        |          |
| [15:3]     | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |            |                    |     |               |       |                     |     |               |        |          |
| 0          | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |            |                    |     |               |       |                     |     |               |        |          |

### 3.10 Device 18h Function 1 Configuration Registers

See 3.1 [Register Descriptions and Mnemonics]. See 2.7 [Configuration Space].

#### D18F1x00 Device/Vendor ID

| Bits  | Description                                          |
|-------|------------------------------------------------------|
| 31:16 | <b>DeviceID:</b> device ID. Read-only. Value: 141Bh. |
| 15:0  | <b>VendorID:</b> vendor ID. Read-only. Value: 1022h. |

#### D18F1x08 Class Code/Revision ID

| Bits | Description                                                                                                           |
|------|-----------------------------------------------------------------------------------------------------------------------|
| 31:8 | <b>ClassCode.</b> Read-only. Value: 060000h. Provides the host bridge class code as defined in the PCI specification. |
| 7:0  | <b>RevID:</b> revision ID. Read-only. Value: 00h. Processor revision. 00h=A0.                                         |

#### D18F1x0C Header Type

Reset: 0080\_0000h.

| Bits | Description                                                                                                                                                              |
|------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:0 | <b>HeaderTypeReg.</b> Read-only. These bits are fixed at their default values. The header type field indicates that there are multiple functions present in this device. |

#### D18F1x[17C:140,7C:40] DRAM Base/Limit

The following sets of registers specify the DRAM address ranges:

Table 123: Register Mapping for D18F1x[17C:140,7C:40]

| Function | Base Low                      | Limit Low                     | Base High                       | Limit High                      |
|----------|-------------------------------|-------------------------------|---------------------------------|---------------------------------|
| Range 0  | D18F1x40                      | D18F1x44                      | D18F1x140                       | D18F1x144                       |
| Reserved | D18F1x48,<br>D18F1x[7:5][8,0] | D18F1x4C,<br>D18F1x[7:5][C,4] | D18F1x148,<br>D18F1x1[7:5][8,0] | D18F1x14C,<br>D18F1x1[7:5][C,4] |

Transaction addresses that are within the specified base/limit range are routed to the DstNode. See 2.8.2 [NB Routing].

DRAM mapping rules:

F1x0XX registers provide the low address bits. F1x1XX registers provide the high address bits.

- Transaction addresses are within the defined range if:  
 $\{\text{DramBase}[47:24], 00\_0000h\} \leq \text{address}[47:0] \leq \{\text{DramLimit}[47:24], FF\_FFFFh\}$ .
- DRAM regions must not overlap each other.
- Accesses to addresses that map to both DRAM, as specified by the DRAM base and limit registers (F1x[1, 0][7C:40]), and MMIO, as specified by D18F1x[2CC:2A0,1CC:180,BC:80], are routed to MMIO only.

- Programming of the DRAM address maps must be consistent with the Memory-Type Range Registers (MTRRs) and the top of memory registers, [MSRC001\\_001A](#) and [MSRC001\\_001D](#). CPU accesses only hit within the DRAM address maps if the corresponding MTRR is of type DRAM. Accesses from IO links are routed based on the DRAM base and limit registers (F1x[1, 0][7C:40]) only.
- The appropriate RE or WE bit(s) must be set. When initializing a base/limit pair, the BIOS must write the [limit] register before either the RE or WE bit is set. When changing a base/limit pair that is already enabled, the BIOS should clear RE and WE before changing the address range.
- See [2.8.2.1.1 \[DRAM and MMIO Memory Space\]](#).

When memory hoisting is enabled in a node via [D18F1x2\[1,0\]\[8,0\]\[LgcyMmioHoleEn\]](#), the corresponding BaseAddr/LimitAddr should be configured to account for the memory hoisted above the hole. See [2.9.12 \[Memory Hoisting\]](#).

### D18F1x[7:4][8,0] DRAM Base Low

IF ([D18F2x118\[LockDramCfg\]](#)) THEN Read-only. ELSE Read-write. ENDIF. Reset: 0000\_0000h.

Table 124: [Register Mapping](#) for [D18F1x\[7:4\]\[8,0\]](#)

| Register         | Function |
|------------------|----------|
| D18F1x40         | Range 0  |
| D18F1x48         | Reserved |
| D18F1x[7:5][8,0] | Reserved |

| Bits  | Description                                                                                                                                                                                      |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:16 | <b>DramBase[39:24]: DRAM base address register bits[39:24].</b><br>DramBase[47:24] = { <a href="#">D18F1x1[7:4][8,0][DramBase[47:40]]</a> , <a href="#">D18F1x[7:4][8,0][DramBase[39:24]]</a> }. |
| 15:2  | Reserved.                                                                                                                                                                                        |
| 1     | <b>WE: write enable.</b> 1=Writes to this address range are enabled.                                                                                                                             |
| 0     | <b>RE: read enable.</b> 1=Reads to this address range are enabled.                                                                                                                               |

### D18F1x1[7:4][8,0] DRAM Base High

Table 125: [Register Mapping](#) for [D18F1x1\[7:4\]\[8,0\]](#)

| Register          | Function |
|-------------------|----------|
| D18F1x140         | Range 0  |
| D18F1x148         | Reserved |
| D18F1x1[7:5][8,0] | Reserved |

| Bits | Description                                                                                                              |
|------|--------------------------------------------------------------------------------------------------------------------------|
| 31:8 | Reserved.                                                                                                                |
| 7:0  | <b>DramBase[47:40]: DRAM base address register bits[47:40].</b> See: <a href="#">D18F1x[7:4][8,0][DramBase[39:24]]</a> . |

**D18F1x[7:4][C,4] DRAM Limit Low**

IF (D18F2x118[LockDramCfg]) THEN Read-only. ELSE Read-write. ENDIF.

Table 126: Register Mapping for D18F1x[7:4][C,4]

| Register         | Function |
|------------------|----------|
| D18F1x44         | Range 0  |
| D18F1x4C         | Reserved |
| D18F1x[7:5][C,4] | Reserved |

| Bits  | Description                                                                                                                                                                      |
|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:16 | <b>DramLimit[39:24]: DRAM limit address register bits[39:24].</b> Reset: FCFFh.<br>DramLimit[47:24] = {D18F1x1[7:4][C,4][DramLimit[47:40]], D18F1x[7:4][C,4][DramLimit[39:24]]}. |
| 15:11 | Reserved.                                                                                                                                                                        |
| 10:8  | Reserved.                                                                                                                                                                        |
| 7:3   | Reserved.                                                                                                                                                                        |
| 2:0   | <b>DstNode: destination Node ID.</b> Reset: 000b. Specifies the node that a packet is routed to if it is within the address range.                                               |

**D18F1x1[7:4][C,4] DRAM Limit High**

IF (D18F2x118[LockDramCfg]) THEN Read-only. ELSE Read-write. ENDIF.

Table 127: Register Mapping for D18F1x1[7:4][C,4]

| Register          | Function |
|-------------------|----------|
| D18F1x144         | Range 0  |
| D18F1x14C         | Reserved |
| D18F1x1[7:5][C,4] | Reserved |

| Bits | Description                                                                                                           |
|------|-----------------------------------------------------------------------------------------------------------------------|
| 31:8 | Reserved.                                                                                                             |
| 7:0  | <b>DramLimit[47:40]: DRAM limit address register bits[47:40].</b> Reset: 00h. See D18F1x[7:4][C,4][DramLimit[39:24]]. |

**D18F1x[2CC:2A0,1CC:180,BC:80] MMIO Base/Limit**

These registers, The memory mapped IO base and limit registers D18F1x[2CC:2A0,1CC:180,BC:80] specify the mapping from memory addresses to the corresponding node and IO link for MMIO transactions. Address ranges are specified by upto 16 sets of base/limit registers.

Table 128: [Register Mapping](#) for D18F1x[2CC:2A0,1CC:180,BC:80]

| Function | MMIO Base Low        | MMIO Limit Low       | MMIO Base/Limit High |
|----------|----------------------|----------------------|----------------------|
| Range 0  | D18F1x80             | D18F1x84             | D18F1x180            |
| Range 1  | D18F1x88             | D18F1x8C             | D18F1x184            |
| Range 2  | D18F1x90             | D18F1x94             | D18F1x188            |
| Range 3  | D18F1x98             | D18F1x9C             | D18F1x18C            |
| Range 4  | D18F1xA0             | D18F1xA4             | D18F1x190            |
| Range 5  | D18F1xA8             | D18F1xAC             | D18F1x194            |
| Range 6  | D18F1xB0             | D18F1xB4             | D18F1x198            |
| Range 7  | D18F1xB8             | D18F1xBC             | D18F1x19C            |
| Range 8  | D18F1x1A0            | D18F1x1A4            | D18F1x1C0            |
| Range 9  | D18F1x1A8            | D18F1x1AC            | D18F1x1C4            |
| Range 10 | D18F1x1B0            | D18F1x1B4            | D18F1x1C8            |
| Range 11 | D18F1x1B8            | D18F1x1BC            | D18F1x1CC            |
| Reserved | D18F1x2[B8,B0,A8,A0] | D18F1x2[BC,B4,AC,A4] | D18F1x2[CC,C8,C4,C0] |

Transaction addresses that are within the specified base/limit range are routed to the node specified by DstNode and the link specified by DstLink. See [2.8.2 \[NB Routing\]](#).

MMIO mapping rules:

- Transaction addresses are within the defined range if:  
 $\{\text{MMIOBase}[47:16], 0000\text{h}\} \leq \text{address}[47:0] \leq \{\text{MMIOLimit}[47:16], \text{FFFFh}\}$ .
- MMIO regions must not overlap each other.
- Accesses to addresses that map to both DRAM, as specified by the DRAM base and limit registers (see [D18F1x\[17C:140,7C:40\]](#)), and MMIO, as specified by the memory mapped IO base and limit registers (F1x[BC:80]), are routed to MMIO only.
- Programming of the MMIO address maps must be consistent with the Memory-Type Range Registers (MTRRs) and the top of memory registers, [MSRC001\\_001A](#) and [MSRC001\\_001D](#). CPU accesses only hit within the MMIO address maps if the corresponding MTRR is of type IO. Accesses from IO links are routed based on [D18F1x\[2CC:2A0,1CC:180,BC:80\]](#).
- The appropriate RE or WE bit(s) must be set. When initializing a base/limit pair, the BIOS must write the limit register before either the RE or WE bit is set. When changing a base/limit pair that is already enabled, the BIOS should clear RE and WE before changing the address range.
- Scenarios in which the address space of multiple MMIO ranges target the same IO device is supported.
- See [2.8.2.1.1 \[DRAM and MMIO Memory Space\]](#).

#### D18F1x[2B:1A,B:8][8,0] MMIO Base Low

Table 129: [Register Mapping](#) for D18F1x[2B:1A,B:8][8,0]

| Register | Function |
|----------|----------|
| D18F1x80 | Range 0  |
| D18F1x88 | Range 1  |
| D18F1x90 | Range 2  |
| D18F1x98 | Range 3  |

Table 129: Register Mapping for D18F1x[2B:1A,B:8][8,0]

|                   |          |
|-------------------|----------|
| D18F1xA0          | Range 4  |
| D18F1xA8          | Range 5  |
| D18F1xB0          | Range 6  |
| D18F1xB8          | Range 7  |
| D18F1x1A0         | Range 8  |
| D18F1x1A8         | Range 9  |
| D18F1x1B0         | Range 10 |
| D18F1x1B8         | Range 11 |
| D18F1x2[B:A][8,0] | Reserved |

| Bits | Description                                                                                                                                                                                                                    |
|------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:8 | <b>MMIOBase[39:16]: MMIO base address register bits[39:16].</b> Read-write. Reset: 0. MMIOBase[47:16] = {D18F1x[2CC:2C0,1CC:1C0,19C:180][MMIOBase[47:40]], MMIO-Base[39:16]}.                                                  |
| 7:4  | Reserved.                                                                                                                                                                                                                      |
| 3    | <b>Lock.</b> Read-write. Reset: 0. 1=the memory mapped IO base and limit registers (D18F1x[2CC:2A0,1CC:180,BC:80]) are read-only (including this bit). WE or RE in this register must be set in order for this to take effect. |
| 2    | Reserved.                                                                                                                                                                                                                      |
| 1    | <b>WE: write enable.</b> Read-write. Reset: 0. 1=Writes to this address range are enabled.                                                                                                                                     |
| 0    | <b>RE: read enable.</b> Read-write. Reset: 0. 1=Reads to this address range are enabled.                                                                                                                                       |

**D18F1x[2B:1A,B:8][C,4] MMIO Limit Low**

Table 130: Register Mapping for D18F1x[2B:1A,B:8][C,4]

| Register             | Function  |
|----------------------|-----------|
| D18F1x84             | Range 0   |
| D18F1x8C             | Range 1   |
| D18F1x94             | Range 2   |
| D18F1x9C             | Range 3   |
| D18F1xA4             | Range 4   |
| D18F1xAC             | Range 5   |
| D18F1xB4             | Range 6   |
| D18F1xBC             | Range 7   |
| D18F1x1A4            | Range 8   |
| D18F1x1AC            | Range 9   |
| D18F1x1B4            | Range 10  |
| D18F1x1BC            | Range 11  |
| D18F1x2[BC,B4,AC,A4] | Reserved. |

| Bits | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |      |             |     |        |     |        |     |        |     |        |
|------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|-----|--------|-----|--------|-----|--------|-----|--------|
| 31:8 | <b>MMIOLimit[39:16]: MMIO limit address register bits[39:16].</b> Read-write. Reset: 0.<br>MMIOLimit[47:16] = {D18F1x[2CC:2C0,1CC:1C0,19C:180][MMIOLimit[47:40]],<br>MMIOLimit[39:16]}.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |      |             |     |        |     |        |     |        |     |        |
| 7    | <b>NP: non-posted.</b> Read-write. Reset: 0. 1=CPU write requests to this MMIO range are passed through the non-posted channel. This may be used to force writes to be non-posted for MMIO regions which map to the legacy ISA/LPC bus, or in conjunction with D18F0x68[DsNpReqLmt] in order to allow downstream CPU requests to be counted and thereby limited to a specified number. This latter use of the NP bit may be used to avoid loop deadlock scenarios in systems that implement a region in an IO device that reflects downstream accesses back upstream. See the link summary of deadlock scenarios for more information. 0=CPU writes to this MMIO range use the posted channel. This bit does not affect requests that come from IO links (the virtual channel of the request is specified by the IO request).<br><br>If two MMIO ranges target the same IO device and the NP bit is set differently in both ranges, unexpected transaction ordering effects are possible. In particular, using PCI- and IO-link-defined producer-consumer semantics, if a producer (e.g., the processor) writes data using a non-posted MMIO range followed by a flag to a posted MMIO range, then it is possible for the device to see the flag updated before the data is updated. |      |             |     |        |     |        |     |        |     |        |
| 6    | <b>DstSubLink: destination sublink.</b> Read-write. Reset: 0. When a link is unganged, this bit specifies the destination sublink of the link specified by the memory mapped IO base and limit registers F1x[BC:80][DstLink]. 0=The destination link is sublink 0. 1=The destination link is sublink 1. If the link is ganged, then this bit must be low.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |      |             |     |        |     |        |     |        |     |        |
| 5:4  | <b>DstLink: destination link ID.</b> Read-write. Reset: 0. For transactions within this MMIO range, this field specifies the destination IO link number of the destination node.<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>Link 0</td></tr> <tr> <td>01b</td><td>Link 1</td></tr> <tr> <td>10b</td><td>Link 2</td></tr> <tr> <td>11b</td><td>Link 3</td></tr> </table>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Bits | Description | 00b | Link 0 | 01b | Link 1 | 10b | Link 2 | 11b | Link 3 |
| Bits | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |      |             |     |        |     |        |     |        |     |        |
| 00b  | Link 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |      |             |     |        |     |        |     |        |     |        |
| 01b  | Link 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |      |             |     |        |     |        |     |        |     |        |
| 10b  | Link 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |      |             |     |        |     |        |     |        |     |        |
| 11b  | Link 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |      |             |     |        |     |        |     |        |     |        |
| 3    | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |      |             |     |        |     |        |     |        |     |        |
| 2:0  | <b>DstNode: destination node ID bits.</b> Read-write. Reset: 0. For transactions within this MMIO range, this field specifies the destination node ID.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |      |             |     |        |     |        |     |        |     |        |

### D18F1x[2CC:2C0,1CC:1C0,19C:180] MMIO Base/Limit High

Table 131: [Register Mapping](#) for D18F1x[2CC:2C0,1CC:1C0,19C:180]

| Register  | Function |
|-----------|----------|
| D18F1x180 | Range 0  |
| D18F1x184 | Range 1  |
| D18F1x188 | Range 2  |
| D18F1x18C | Range 3  |
| D18F1x190 | Range 4  |
| D18F1x194 | Range 5  |



Table 131: [Register Mapping](#) for [D18F1x\[2CC:2C0,1CC:1C0,19C:180\]](#)

|                |          |
|----------------|----------|
| D18F1x198      | Range 6  |
| D18F1x19C      | Range 7  |
| D18F1x1C0      | Range 8  |
| D18F1x1C4      | Range 9  |
| D18F1x1C8      | Range 10 |
| D18F1x1CC      | Range 11 |
| D18F1x2[CC:C0] | Reserved |

| Bits  | Description                                                                                                                       |
|-------|-----------------------------------------------------------------------------------------------------------------------------------|
| 31:24 | Reserved.                                                                                                                         |
| 23:16 | <b>MMIOLimit[47:40]: MMIO limit address register bits[47:40].</b> See: <a href="#">D18F1x[2B:1A,B:8][C,4][MMIOLimit[39:16]]</a> . |
| 15:8  | Reserved.                                                                                                                         |
| 7:0   | <b>MMIOBase[47:40]: MMIO base address register bits[47:40].</b> See: <a href="#">D18F1x[2B:1A,B:8][8,0][MMIOBase[39:16]]</a> .    |

### **D18F1x[DC:C0] IO-Space Base/Limit**

The IO-space base and limit registers, [D18F1x\[DC:C0\]](#), specify the mapping from IO addresses to the corresponding node and IO link for transactions resulting from x86-defined IN and OUT instructions. IO address ranges are specified by upto 8 sets of base/limit registers. The first set is F1xC0 and F1xC4, the second set is F1xC8 and F1xCC, and so forth. Transaction addresses that are within the specified base/limit range are routed to the node specified by DstNode and the link specified by DstLink. See [2.8.2 \[NB Routing\]](#).

IO mapping rules:

- IO-space transaction addresses are within the defined range if:  
{IOBase[24:12], 000h} <= address <= {IOLimit[24:12], FFFh} and as specified by the IE bit; or  
if the address is in the range specified by the VE bits.
- IO regions must not overlap each other.
- The appropriate RE or WE bit(s) must be set.
- See [2.8.2.1.2 \[IO Space\]](#).

### **D18F1x[1F:1E,D:C][8,0] IO-Space Base**

Table 132: [Register Mapping](#) for [D18F1x\[1F:1E,D:C\]\[8,0\]](#)

| Register          | Function |
|-------------------|----------|
| D18F1xC0          | Range 0  |
| D18F1xC8          | Range 1  |
| D18F1xD0          | Range 2  |
| D18F1xD8          | Range 3  |
| D18F1x1[F:E][8,0] | Reserved |

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:25 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 24:12 | <b>IOBase[24:12]: IO base address register bits[24:12].</b> Read-write. Reset: 0.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 11:6  | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 5     | <b>IE: ISA enable.</b> Read-write. Reset: 0. 1=The IO-space address window is limited to the first 256 B of each 1 KB block specified; this only applies to the first 64 KB of IO space. 0=The PCI IO window is not limited in this way.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 4     | <b>VE: VGA enable.</b> Read-write. Reset: 0. 1=Include IO-space transactions targeting the VGA-compatible address space within the IO-space window of this base/limit pair. These include IO accesses in which address bits[9:0] range from 3B0h to 3BBh or 3C0h to 3DFh (address bits[15:10] are not decoded); this only applies to the first 64 KB of IO space; i.e., address bits[24:16] must be low). 0=IO-space transactions targeting VGA-compatible address ranges are not added to the IO-space window. This bit should only ever be set in one register. The MMIO range associated with the VGA enable bit in the PCI specification is NOT included in the VE bit definition; to map this range to an IO link, see <a href="#">D18F1xF4 [VGA Enable]</a> . When <a href="#">D18F1xF4[VE]</a> is set, the state of this bit is ignored. |
| 3:2   | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 1     | <b>WE: write enable.</b> Read-write. Reset: 0. 1=Writes to this IO-space address range are enabled.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| 0     | <b>RE: read enable.</b> Read-write. Reset: 0. 1=Reads to this IO-space address range are enabled.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |

### D18F1x[1F:1E,D:C][C,4] IO-Space Limit

Table 133: [Register Mapping](#) for [D18F1x\[1F:1E,D:C\]\[C,4\]](#)

| Register          | Function |
|-------------------|----------|
| D18F1xC4          | Range 0  |
| D18F1xCC          | Range 1  |
| D18F1xD4          | Range 2  |
| D18F1xDC          | Range 3  |
| D18F1x1[F:E][C,4] | Reserved |

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                               |      |             |     |        |     |        |     |        |     |        |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|-----|--------|-----|--------|-----|--------|-----|--------|
| 31:25 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                 |      |             |     |        |     |        |     |        |     |        |
| 24:12 | <b>IOLimit[24:12]: IO limit address register bits[24:12].</b> Read-write. Reset: 0.                                                                                                                                                                                                                                                                                                                       |      |             |     |        |     |        |     |        |     |        |
| 11:7  | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                 |      |             |     |        |     |        |     |        |     |        |
| 6     | <b>DstSubLink: destination sublink.</b> Read-write. Reset: 0. When a link is unganged, this bit specifies the destination sublink of the link specified by F1x[DC:C0][DstLink]. 0=The destination link is sublink 0. 1=The destination link is sublink 1. If the link is ganged, then this bit must be low.                                                                                               |      |             |     |        |     |        |     |        |     |        |
| 5:4   | <b>DstLink: destination link ID.</b> Read-write. Reset: 0. For transactions within this IO-space range, this field specifies the destination IO link number of the destination node. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>Link 0</td></tr> <tr> <td>01b</td><td>Link 1</td></tr> <tr> <td>10b</td><td>Link 2</td></tr> <tr> <td>11b</td><td>Link 3</td></tr> </table> | Bits | Description | 00b | Link 0 | 01b | Link 1 | 10b | Link 2 | 11b | Link 3 |
| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                               |      |             |     |        |     |        |     |        |     |        |
| 00b   | Link 0                                                                                                                                                                                                                                                                                                                                                                                                    |      |             |     |        |     |        |     |        |     |        |
| 01b   | Link 1                                                                                                                                                                                                                                                                                                                                                                                                    |      |             |     |        |     |        |     |        |     |        |
| 10b   | Link 2                                                                                                                                                                                                                                                                                                                                                                                                    |      |             |     |        |     |        |     |        |     |        |
| 11b   | Link 3                                                                                                                                                                                                                                                                                                                                                                                                    |      |             |     |        |     |        |     |        |     |        |

|     |                                                                                                                                                            |
|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 3   | Reserved.                                                                                                                                                  |
| 2:0 | <b>DstNode: destination node ID bits.</b> Read-write. Reset: 0. For transactions within this IO-space range, this field specifies the destination node ID. |

### D18F1x[1DC:1D0,EC:E0] Configuration Map

**D18F1x[1DC:1D0,EC:E0]** specify the mapping from configuration address to the corresponding node and IO link. Configuration address ranges are specified by upto 8 pairs of base/limit registers. Transaction addresses that are within the specified base/limit range are routed to the node specified by DstNode and the link specified by DstLink. See 2.8.2 [NB Routing].

Table 134: Register Mapping for D18F1x[1DC:1D0,EC:E0]

| Register       | Function |
|----------------|----------|
| D18F1xE0       | Range 0  |
| D18F1xE4       | Range 1  |
| D18F1xE8       | Range 2  |
| D18F1xEC       | Range 3  |
| D18F1x1[DC:D0] | Reserved |

Configuration space mapping rules:

- Configuration addresses (to “BusNo” and “Device” as specified by [IOCF8 \[IO-Space Configuration Address\]](#) in the case of IO accesses or [2.7 \[Configuration Space\]](#) in the case of MMIO accesses) are within the defined range if:  
 $(\{BusNumBase[7:0]\} \leq BusNo \leq \{BusNumLimit[7:0]\}) \& (DevCmpEn==0);$  or  
 $(\{BusNumBase[4:0]\} \leq Device \leq \{BusNumLimit[4:0]\}) \& (DevCmpEn==1) \& (BusNo == 00h).$
- Configuration regions must not overlap each other.
- The appropriate RE or WE bit(s) must be set.
- See 2.8.2.1.3 [Configuration Space].

| Bits  | Description                                                                                                                                                                                     |
|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:24 | <b>BusNumLimit[7:0]: bus number limit bits[7:0].</b> Read-write. Reset: 0.                                                                                                                      |
| 23:16 | <b>BusNumBase[7:0]: bus number base bits[7:0].</b> Read-write. Reset: 0.                                                                                                                        |
| 15:3  | Reserved.                                                                                                                                                                                       |
| 2     | <b>DevCmpEn: device number compare mode enable.</b> Read-write. Reset: 0. 1=A device number range rather than a bus number range is used to specify the configuration-space window (see above). |
| 1     | <b>WE: write enable.</b> Read-write. Reset: 0. 1=Writes to this configuration-space address range are enabled.                                                                                  |
| 0     | <b>RE: read enable.</b> Read-write. Reset: 0. 1=Reads to this configuration-space address range are enabled.                                                                                    |

### D18F1xF0 DRAM Hole Address

IF (**D18F2x118[LockDramCfg]**) THEN Read-only. ELSE Read-write. ENDIF. Same-for-all. Reset: 0000\_0000h. See 2.9.12 [Memory Hoisting].

| Bits  | Description                                                                                                                                                                                                                                                    |
|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:24 | <b>DramHoleBase[31:24]: DRAM hole base address.</b> Specifies the base address of the IO hole, below the 4GB address level, that is used in memory hoisting. Normally, $\text{DramHoleBase} \geq \text{MSRC001\_001A}[\text{TOM}[31:24]]$ .                    |
| 23:16 | Reserved.                                                                                                                                                                                                                                                      |
| 15:7  | <b>DramHoleOffset[31:23]: DRAM hole offset address.</b> When $\text{D18F1x2}[1,0][8,0][\text{LgcyMmioHoleEn}] = 1$ , this offset is subtracted from the physical address of certain accesses in forming the normalized address.                                |
| 6:3   | Reserved.                                                                                                                                                                                                                                                      |
| 2     | Reserved.                                                                                                                                                                                                                                                      |
| 1     | <b>DramMemHoistValid: dram memory hoist valid.</b> 1=Memory hoisting for the address range is enabled. 0=Memory hoisting is not enabled. This bit should be set if any $\text{D18F1x2}[1,0][8,0][\text{LgcyMmioHoleEn}] = 1$ or $\text{DramHoleBase} \neq 0$ . |
| 0     | <b>DramHoleValid: dram hole valid.</b> 1=Memory hoisting is enabled in the node. 0=Memory hoisting is not enabled. This bit should be set in the node that owns the DRAM address space that is hoisted above the 4 GB address level. See <i>DramHoleBase</i> . |

### D18F1xF4 VGA Enable

Reset: 0000\_0000h. All these bits are read-write unless Lock is set.

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                  |      |             |     |        |     |        |     |        |     |        |
|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|-----|--------|-----|--------|-----|--------|-----|--------|
| 31:15 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                    |      |             |     |        |     |        |     |        |     |        |
| 14    | <b>DstSubLink: destination sublink.</b> Read-write. When a link is unganged, this bit specifies the destination sublink of the link specified by $\text{D18F1xF4}[\text{DstLink}]$ . 0=The destination link is sublink 0. 1=The destination link is sublink 1. If the link is ganged, then this bit must be low.                                                                                                             |      |             |     |        |     |        |     |        |     |        |
| 13:12 | <b>DstLink: destination link ID.</b> Read-write. For transactions within the $\text{D18F1xF4}[\text{VE}]$ -defined ranges, this field specifies the destination IO link number of the destination node. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>Link 0</td></tr> <tr> <td>01b</td><td>Link 1</td></tr> <tr> <td>10b</td><td>Link 2</td></tr> <tr> <td>11b</td><td>Link 3</td></tr> </table> | Bits | Description | 00b | Link 0 | 01b | Link 1 | 10b | Link 2 | 11b | Link 3 |
| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                  |      |             |     |        |     |        |     |        |     |        |
| 00b   | Link 0                                                                                                                                                                                                                                                                                                                                                                                                                       |      |             |     |        |     |        |     |        |     |        |
| 01b   | Link 1                                                                                                                                                                                                                                                                                                                                                                                                                       |      |             |     |        |     |        |     |        |     |        |
| 10b   | Link 2                                                                                                                                                                                                                                                                                                                                                                                                                       |      |             |     |        |     |        |     |        |     |        |
| 11b   | Link 3                                                                                                                                                                                                                                                                                                                                                                                                                       |      |             |     |        |     |        |     |        |     |        |
| 11:7  | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                    |      |             |     |        |     |        |     |        |     |        |

|     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|-----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 6:4 | <b>DstNode: destination node ID.</b> Read-write. For transactions within the <a href="#">D18F1xF4[VE]</a> -defined range, this field specifies the destination node ID.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| 3   | <b>Lock.</b> Read-write. 1=All the bits in this register ( <a href="#">D18F1xF4</a> ) are read-only (including this bit).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| 2   | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| 1   | <b>NP: non-posted.</b> Read-write. 1=CPU write requests to the <a href="#">D18F1xF4[VE]</a> -defined MMIO range are passed through the non-posted channel. 0=CPU writes may be posted.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| 0   | <b>VE: VGA enable.</b> Read-write. 1=Transactions targeting the VGA-compatible address space are routed and controlled as specified by this register. The VGA-compatible address space is: (1) the MMIO range <a href="#">A_0000h</a> through <a href="#">B_FFFFh</a> ; (2) IO-space accesses in which address bits[9:0] range from <a href="#">3B0h</a> to <a href="#">3BBh</a> or <a href="#">3C0h</a> to <a href="#">3DFh</a> (address bits[15:10] are not decoded; this only applies to the first 64 KB of IO space; i.e., address bits[24:16] must be low). 0=Transactions targeting the VGA-compatible address space are not affected by the state of this register. When this bit is set, the state of <a href="#">D18F1xF4[VE]</a> is ignored. |

### D18F1x10C DCT Configuration Select

Reset: 0000\_0000h.

| Bits        | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |             |                    |     |              |     |              |     |              |     |              |
|-------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|--------------------|-----|--------------|-----|--------------|-----|--------------|-----|--------------|
| 31:8        | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |             |                    |     |              |     |              |     |              |     |              |
| 7           | <b>DctCfgBcEn: Dct config write broadcast enable.</b> Read-write. 1=For a logical CSR write to <a href="#">D18F2x98_dct[3:0]</a> or <a href="#">D18F2x9C_dct[3:0]</a> , all enabled DCTs receive the config data. 0=Only the DCT specified with DctCfgSel receives the config data of a config write. For a logical CSR read, DctCfgBcEn=x and the DCT with DctCfgSel supplies the read data.                                                                                                                                                                                                                                                                                                                                         |             |                    |     |              |     |              |     |              |     |              |
| 6           | Unused.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |             |                    |     |              |     |              |     |              |     |              |
| 5:4         | <p><b>NbPsSel: NB P-state configuration select.</b> Read-write. Specifies the set of DCT Pstate registers to which accesses are routed.</p> <table> <tr> <th><u>Bits</u></th><th><u>Description</u></th></tr> <tr> <td>00b</td><td>NB P-state 0</td></tr> <tr> <td>01b</td><td>NB P-state 1</td></tr> <tr> <td>10b</td><td>NB P-state 2</td></tr> <tr> <td>11b</td><td>NB P-state 3</td></tr> </table> <p>The following registers must be programmed for each NB P-state enabled by <a href="#">D18F5x16[C:0][NbPstateEn]</a>:</p> <ul style="list-style-type: none"> <li>• <a href="#">D18F2x210_dct[3:0]_nbp[3:0][MaxRdLatency, DataTxFifoWrDly]</a>.</li> <li>• <a href="#">D18F2x210_dct[3:0]_nbp[3:0][RdPtrInit]</a>.</li> </ul> | <u>Bits</u> | <u>Description</u> | 00b | NB P-state 0 | 01b | NB P-state 1 | 10b | NB P-state 2 | 11b | NB P-state 3 |
| <u>Bits</u> | <u>Description</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |             |                    |     |              |     |              |     |              |     |              |
| 00b         | NB P-state 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |             |                    |     |              |     |              |     |              |     |              |
| 01b         | NB P-state 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |             |                    |     |              |     |              |     |              |     |              |
| 10b         | NB P-state 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |             |                    |     |              |     |              |     |              |     |              |
| 11b         | NB P-state 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |             |                    |     |              |     |              |     |              |     |              |

| 3    | <b>MemPsSel: Memory P-state configuration select.</b> Read-write. Specifies the set of DCT controller registers to which accesses are routed. This register works independently of NbPsSel. 0=Memory P-state 0. 1=Memory P-state 1. See <a href="#">2.5.7.1 [Memory P-states]</a> and <a href="#">2.9.3 [DCT Configuration Registers]</a> . The following registers must be programmed for each memory P-state enabled by <a href="#">D18F5x16[C:0][MemPstate]</a> : <ul style="list-style-type: none"> <li>• <a href="#">D18F2x2E8_dct[3:0]_mp[1:0]</a></li> <li>• <a href="#">D18F2x2EC_dct[3:0]_mp[1:0]</a></li> </ul> |      |             |      |       |      |       |      |       |      |       |
|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|------|-------|------|-------|------|-------|------|-------|
| 2:0  | <b>DctCfgSel: DRAM controller configuration select.</b> Read-write. Specifies DCT controller to which accesses are routed. See <a href="#">2.9.3 [DCT Configuration Registers]</a> . <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>000b</td><td>DCT 0</td></tr> <tr> <td>001b</td><td>DCT 1</td></tr> <tr> <td>010b</td><td>DCT 2</td></tr> <tr> <td>011b</td><td>DCT 3</td></tr> </table>                                                                                                                                                                                                                 | Bits | Description | 000b | DCT 0 | 001b | DCT 1 | 010b | DCT 2 | 011b | DCT 3 |
| Bits | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |      |             |      |       |      |       |      |       |      |       |
| 000b | DCT 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |      |             |      |       |      |       |      |       |      |       |
| 001b | DCT 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |      |             |      |       |      |       |      |       |      |       |
| 010b | DCT 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |      |             |      |       |      |       |      |       |      |       |
| 011b | DCT 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |      |             |      |       |      |       |      |       |      |       |

### D18F1x120 DRAM Base System Address

IF ([D18F2x118\[LockDramCfg\]](#)) THEN Read-only. ELSE Read-write. ENDIF. Cold reset: 0000\_0000h.

[D18F1x120](#) and [D18F1x124](#) are required to specify the base and limit system address range of the DRAM connected to the local node.

DRAM accesses to the local node with physical address Addr[47:0] that are within the following range are directed to the DCTs:

{DramBaseAddr[47:27], 000\_0000h} <= Addr[47:0] <= {DramLimitAddr[47:27], 7FF\_FFFFh};

DRAM accesses to the local node that are outside of this range are master aborted.

The address of the DRAM transaction is normalized before passing it to the DCTs by subtracting DramBaseAddr.

This range is also used to specify the range of DRAM covered by the scrubber (see [D18F3x58](#) and [D18F3x5C](#)).

| Bits  | Description                 |
|-------|-----------------------------|
| 31:21 | Reserved.                   |
| 20:0  | <b>DramBaseAddr[47:27].</b> |

### D18F1x124 DRAM Limit System Address

IF ([D18F2x118\[LockDramCfg\]](#)) THEN Read-only. ELSE Read-write. ENDIF. See [D18F1x120 \[DRAM Base System Address\]](#).

| Bits  | Description                                        |
|-------|----------------------------------------------------|
| 31:24 | Reserved                                           |
| 23:21 | Reserved.                                          |
| 20:0  | <b>DramLimitAddr[47:27].</b> Cold reset: 1F_FFFFh. |

**D18F1x2[1C:00] DRAM Controller Base/Limit**

The DRAM controller base and limit registers define a DRAM controller address range and specify the mapping of physical DRAM addresses to a DCT as selected by DctSel or DctIntLvEn. The following base/limit register pairs specify the address ranges:

Table 135: [Register Mapping](#) for D18F1x2[1C:00]

| Function | Base Address | Limit Address |
|----------|--------------|---------------|
| Range 0  | D18F1x200    | D18F1x204     |
| Range 1  | D18F1x208    | D18F1x20C     |
| Range 2  | D18F1x210    | D18F1x214     |
| Range 3  | D18F1x218    | D18F1x21C     |

BIOS should observe the following DCT configuration requirements:

- DRAM addresses are within the defined range if:  
 $\{\text{DctBaseAddr}[47:27], 000b, 00\_0000h\} \leq \text{address}[47:0] \leq \{\text{DctLimitAddr}[47:27], 111b, FF\_FFFFh\}$ .
- DCT base/limit address ranges must not overlap each other.
- A maximum of two address ranges may be mapped to a single DCT.

**Hoisting.** When memory hoisting is enabled via LegacyMmioHoleEn, the corresponding DctBaseAddr/DctLimitAddr should be configured to account for the memory hoisted above the hole. A contiguous memory hole should only be mapped by one DctBaseAddr/DctLimitAddr pair. See [2.9.12 \[Memory Hoisting\]](#).

**Channel interleaving.** A DRAM address range may be mapped to one DCT as a continuous region, or it may be interleaved between DCTs. See [2.9.11.2 \[Channel Interleaving\]](#).

**D18F1x2[1,0][8,0] DRAM Controller Base**

IF (D18F2x118[LockDramCfg]) THEN Read-only. ELSE Read-write. ENDIF. Reset: 0000\_0000h.

Table 136: [Register Mapping](#) for D18F1x2[1,0][8,0]

| Register  | Function |
|-----------|----------|
| D18F1x200 | Range 0  |
| D18F1x208 | Range 1  |
| D18F1x210 | Range 2  |
| D18F1x218 | Range 3  |

| Bits  | Description                                                                                                                                   |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------|
| 31:11 | <b>DctBaseAddr[47:27]: DRAM controller base address [47:27].</b> Read-write. Specifies the base physical address bits for this address range. |
| 10:7  | Reserved.                                                                                                                                     |

| 6:4       | <b>DctSel: DRAM controller select.</b> Read-write. Specifies the DCT mapped to this address range.<br><br>Ignored if ( <a href="#">D18F1x2[1,0][C,4][DctIntLvEn]</a> != 0).<br><table> <tr> <th>Bits</th><th>Definition</th></tr> <tr> <td>011b-000b</td><td>DCT &lt;<i>DctSel</i>&gt;</td></tr> <tr> <td>111b-100b</td><td>Reserved</td></tr> </table> | Bits | Definition | 011b-000b | DCT < <i>DctSel</i> > | 111b-100b | Reserved |
|-----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------------|-----------|-----------------------|-----------|----------|
| Bits      | Definition                                                                                                                                                                                                                                                                                                                                              |      |            |           |                       |           |          |
| 011b-000b | DCT < <i>DctSel</i> >                                                                                                                                                                                                                                                                                                                                   |      |            |           |                       |           |          |
| 111b-100b | Reserved                                                                                                                                                                                                                                                                                                                                                |      |            |           |                       |           |          |
| 3         | <b>DctOffsetEn: DRAM controller offset enable.</b> Read-write. BIOS: See <a href="#">2.9.12.2 [DctSelBaseOffset Programming]</a> . 1=Add the offset specified by <a href="#">D18F1x2[4C:40][DctHighAddrOffset]</a> to accesses in this address range in forming the normalized address. 0=Addition of the offset is not enabled.                        |      |            |           |                       |           |          |
| 2         | Reserved.                                                                                                                                                                                                                                                                                                                                               |      |            |           |                       |           |          |
| 1         | <b>LgcyMmioHoleEn: legacy mmio hole enable.</b> Read-write. BIOS: See <a href="#">2.9.12 [Memory Hoisting]</a> . 1=Enable memory hoisting for this address range. BIOS sets this bit for an address range that spans the 4GB boundary and contains a hole for addresses used by MMIO. 0=Memory hoisting is not enabled.                                 |      |            |           |                       |           |          |
| 0         | <b>DctAddrVal: DRAM controller address valid.</b> Read-write. 1=Specifies this address range is valid and enabled. 0=This address range is not enabled.                                                                                                                                                                                                 |      |            |           |                       |           |          |

#### D18F1x2[1,0][C,4] DRAM Controller Limit

IF ([D18F2x118\[LockDramCfg\]](#)) THEN Read-only. ELSE Read-write. ENDIF. Reset: 0000\_0000h.

Table 137: [Register Mapping](#) for [D18F1x2\[1,0\]\[C,4\]](#)

| Register  | Function |
|-----------|----------|
| D18F1x204 | Range 0  |
| D18F1x20C | Range 1  |
| D18F1x214 | Range 2  |
| D18F1x21C | Range 3  |

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                        |     |            |     |       |     |       |     |       |     |       |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|------------|-----|-------|-----|-------|-----|-------|-----|-------|
| 31:11 | <b>DctLimitAddr[47:27]: DRAM controller limit address bits [47:27].</b> Read-write. Specifies the limit physical address bits for this address range.                                                                                                                                                                                                                                                              |     |            |     |       |     |       |     |       |     |       |
| 10:4  | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                          |     |            |     |       |     |       |     |       |     |       |
| 3:0   | <b>DctIntLvEn: DRAM controller interleave enable.</b> Read-write. BIOS: See <a href="#">2.9.11.2 [Channel Interleaving]</a> . 1=DCT participates in channel interleaving for this address range.<br><table> <tr> <th>Bit</th><th>Definition</th></tr> <tr> <td>[0]</td><td>DCT 0</td></tr> <tr> <td>[1]</td><td>DCT 1</td></tr> <tr> <td>[2]</td><td>DCT 2</td></tr> <tr> <td>[3]</td><td>DCT 3</td></tr> </table> | Bit | Definition | [0] | DCT 0 | [1] | DCT 1 | [2] | DCT 2 | [3] | DCT 3 |
| Bit   | Definition                                                                                                                                                                                                                                                                                                                                                                                                         |     |            |     |       |     |       |     |       |     |       |
| [0]   | DCT 0                                                                                                                                                                                                                                                                                                                                                                                                              |     |            |     |       |     |       |     |       |     |       |
| [1]   | DCT 1                                                                                                                                                                                                                                                                                                                                                                                                              |     |            |     |       |     |       |     |       |     |       |
| [2]   | DCT 2                                                                                                                                                                                                                                                                                                                                                                                                              |     |            |     |       |     |       |     |       |     |       |
| [3]   | DCT 3                                                                                                                                                                                                                                                                                                                                                                                                              |     |            |     |       |     |       |     |       |     |       |

#### D18F1x2[4C:40] DRAM Controller High Address Offset Register

IF ([D18F2x118\[LockDramCfg\]](#)) THEN Read-only. ELSE Read-write. ENDIF. Reset: 0000\_0000h.



Table 138: [Register Mapping](#) for [D18F1x2\[4C:40\]](#)

| Register  | Function |
|-----------|----------|
| D18F1x240 | DCT 0    |
| D18F1x244 | DCT 1    |
| D18F1x248 | DCT 2    |
| D18F1x24C | DCT 3    |

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:23 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 22:11 | <b>DctHighAddrOffset[38:27]: DRAM controller high address offset.</b> When <a href="#">D18F1x2[1,0][8,0][DctOffsetEn]</a> =1, specifies the offset added by the DCT in forming the normalized address for that range. When a DCT is mapped by two ranges, this offset places the normalized address above those mapped by a previous <a href="#">D18F1x2[1C:00]</a> address range. Reserved if <a href="#">D18F1x2[1,0][8,0][DctOffsetEn]</a> !=1. |
| 10:0  | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                          |

### 3.11 Device 18h Function 2 Configuration Registers

See 3.1 [Register Descriptions and Mnemonics]. See 2.7 [Configuration Space].

#### D18F2x00 Device/Vendor ID

| Bits  | Description                                          |
|-------|------------------------------------------------------|
| 31:16 | <b>DeviceID:</b> device ID. Read-only. Value: 141Ch. |
| 15:0  | <b>VendorID:</b> vendor ID. Read-only. Value: 1022h. |

#### D18F2x08 Class Code/Revision ID

Reset: 0600\_0000h.

| Bits | Description                                                                                           |
|------|-------------------------------------------------------------------------------------------------------|
| 31:8 | <b>ClassCode.</b> Read-only. Provides the host bridge class code as defined in the PCI specification. |
| 7:0  | <b>RevID:</b> revision ID. Read-only.                                                                 |

#### D18F2x0C Header Type

Reset: 0080\_0000h.

| Bits | Description                                                                                                                                                          |
|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:0 | <b>HeaderTypeReg.</b> Read-only. These bits are fixed at their default values. The header type field indicates that there multiple functions present in this device. |

#### D18F2x[5C:40]\_dct[3:0] DRAM CS Base Address

See 2.9.3 [DCT Configuration Registers].

These registers along with D18F2x[6C:60]\_dct[3:0] [DRAM CS Mask], translate DRAM request addresses (to a DRAM controller) into DRAM chip selects. Supported DIMM sizes are specified in D18F2x80\_dct[3:0] [DRAM Bank Address Mapping]. For more information on the DRAM controllers, see 2.9 [DRAM Controllers (DCTs)].

For each chip select, there is a DRAM CS Base Address register. For each CS pair there is a DRAM CS Mask Register. For each CS pair, an even CS must be populated if the odd CS is populated. If a chipselect is populated in the system it must be indicated to the DCT by setting one of the mutually exclusive {CSEnable, TestFail} configuration bits.

**Table 139: DIMM, Chip Select, and Register Mapping**

| Base Address Registers | Mask Register | Logical DIMM | Chip Select <sup>1</sup> |
|------------------------|---------------|--------------|--------------------------|
| D18F2x40_dct[x]        | F2x60         | 0            | MEMCS[x]_L[0]            |
| D18F2x44_dct[x]        |               |              | MEMCS[x]_L[1]            |

**Table 139: DIMM, Chip Select, and Register Mapping**

| Base Address Registers                          | Mask Register | Logical DIMM | Chip Select <sup>1</sup> |
|-------------------------------------------------|---------------|--------------|--------------------------|
| D18F2x48_dct[x]                                 | F2x64         | 1            | MEMCS[x]_L[2]            |
| D18F2x4C_dct[x]                                 |               |              | MEMCS[x]_L[3]            |
| D18F2x[5C:50]_dct[x]                            | F2x6[C,8]     | Reserved     |                          |
| 1. See 2.9.4 [DDR Pad to Processor Pin Mapping] |               |              |                          |

The DRAM controller operates on the normalized physical address of the DRAM request. The normalized physical address includes all of the address bits that are supported by a DRAM controller. See 2.8 [Northbridge (NB)].

Each base address register specifies the starting normalized address of the block of memory associated with the chip select. Each mask register specifies the additional address bits that are consumed by the block of memory associated with the chip selects. If both chip selects of a DIMM are used, they must be the same size; in this case, a single mask register covers the address space consumed by both chip selects.

Lower-order address bits are provided in the base address and mask registers, as well. These allow memory to be interleaved between chip selects, such that contiguous physical addresses map to the same DRAM page of multiple chip selects. See 2.9.11.1 [Chip Select Interleaving]. The hardware supports the use of lower-order address bits to interleave chip selects if (1) the each chip select of the memory system spans the same amount of memory and (2) the number of chip selects of the memory system is a power of two.

BIOS is required to assign the largest DIMM chip-select range to the lowest normalized address of the DRAM controller. As addresses increase, the chip-select size is required to remain constant or decrease. This is necessary to keep DIMM chip-select banks on aligned address boundaries, regardless as to the amount of address space covered by each chip select.

For each normalized address for requests that enters a DRAM controller, a ChipSelect[i] is asserted if:

```
CSEnable[i] &
( { (InputAddr[38:27] & ~AddrMask[i][38:27]),
    (InputAddr[21:11] & ~AddrMask[i][21:11]) } ==
  { (BaseAddr[i][38:27] & ~AddrMask[i][38:27]),
    (BaseAddr[i][21:11] & ~AddrMask[i][21:11]) } );
```

| Bits  | Description                                                                                                                                          |
|-------|------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31    | Reserved.                                                                                                                                            |
| 30:19 | <b>BaseAddr[38:27]: normalized physical base address bits [38:27].</b> IF (D18F2x118[LockDramCfg]) THEN Read-only. ELSE Read-write. ENDIF. Reset: 0. |
| 18:16 | Reserved.                                                                                                                                            |
| 15:5  | <b>BaseAddr[21:11]: normalized physical base address bits [21:11].</b> IF (D18F2x118[LockDramCfg]) THEN Read-only. ELSE Read-write. ENDIF. Reset: 0. |
| 4     | Reserved.                                                                                                                                            |

|   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|---|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 3 | <b>OnDimmMirror: on-DIMM mirroring (ODM) enabled.</b> IF (D18F2x118[LockDramCfg]) THEN Read-only. ELSE Read-write. ENDIF. Reset: 0. 1=Address and bank bits are swapped by hardware for MRS commands sent to this chip select. This mode accounts for routing on the DIMM. Hardware bit swapping does not occur for commands sent via D18F2x7C_dct[3:0][SendMrsCmd] when D18F2x7C_dct[3:0][EnDramInit] = 0. This bit is expected to be set for the odd numbered rank of unbuffered DDR3 DIMMs if SPD byte 63 indicates that address mapping is mirrored. The following bits are swapped when enabled: <ul style="list-style-type: none"> <li>• BA0 and BA1.</li> <li>• A3 and A4.</li> <li>• A5 and A6.</li> <li>• A7 and A8.</li> </ul> |
| 2 | <b>TestFail: memory test failed.</b> IF (D18F2x118[LockDramCfg]) THEN Read-only. ELSE Read-write. ENDIF. Reset: 0. Set by BIOS to indicate that a rank is present but has failed memory training or a memory consistency test, indicating that the memory is bad or unused.                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| 1 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| 0 | <b>CSEnable: chip select enable.</b> IF (D18F2x118[LockDramCfg]) THEN Read-only. ELSE Read-write. ENDIF. Reset: 0.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |

#### D18F2x[6C:60]\_dct[3:0] DRAM CS Mask

See 2.9.3 [DCT Configuration Registers]. See D18F2x[5C:40]\_dct[3:0].

| Bits  | Description                                                                                                                                          |
|-------|------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31    | Reserved.                                                                                                                                            |
| 30:19 | <b>AddrMask[38:27]: normalized physical address mask bits [38:27].</b> IF (D18F2x118[LockDramCfg]) THEN Read-only. ELSE Read-write. ENDIF. Reset: 0. |
| 18:16 | Reserved.                                                                                                                                            |
| 15:5  | <b>AddrMask[21:11]: normalized physical address mask bits [21:11].</b> IF (D18F2x118[LockDramCfg]) THEN Read-only. ELSE Read-write. ENDIF. Reset: 0. |
| 4     | Reserved.                                                                                                                                            |
| 3:2   | Reserved.                                                                                                                                            |
| 1:0   | Reserved.                                                                                                                                            |

#### D18F2x78\_dct[3:0] DRAM Control

See 2.9.3 [DCT Configuration Registers].

| Bits  | Description                                                                                                                                                                       |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31    | Reserved.                                                                                                                                                                         |
| 30:18 | Reserved.                                                                                                                                                                         |
| 17    | <b>AddrCmdTriEn: address command tristate enable.</b> Read-write. Reset: 0. BIOS: See 2.9.9.4. 1=Tristate the address, command, and bank buses when a Deselect command is issued. |

| 16        | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                      |      |             |      |      |      |          |      |          |      |          |           |          |      |           |
|-----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|------|------|------|----------|------|----------|------|----------|-----------|----------|------|-----------|
| 15        | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                      |      |             |      |      |      |          |      |          |      |          |           |          |      |           |
| 14:11     | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                      |      |             |      |      |      |          |      |          |      |          |           |          |      |           |
| 10:8      | <b>DramType: DRAM type.</b> Read-write. Reset: 7h. Specifies the type of DRAM devices which are connected to this DCT.<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>000b</td><td>DDR3</td></tr> <tr> <td>001b</td><td>Reserved</td></tr> <tr> <td>010b</td><td>Reserved</td></tr> <tr> <td>011b</td><td>Reserved</td></tr> <tr> <td>110b-100b</td><td>Reserved</td></tr> <tr> <td>111b</td><td>Undefined</td></tr> </table> | Bits | Description | 000b | DDR3 | 001b | Reserved | 010b | Reserved | 011b | Reserved | 110b-100b | Reserved | 111b | Undefined |
| Bits      | Description                                                                                                                                                                                                                                                                                                                                                                                                                                    |      |             |      |      |      |          |      |          |      |          |           |          |      |           |
| 000b      | DDR3                                                                                                                                                                                                                                                                                                                                                                                                                                           |      |             |      |      |      |          |      |          |      |          |           |          |      |           |
| 001b      | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                       |      |             |      |      |      |          |      |          |      |          |           |          |      |           |
| 010b      | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                       |      |             |      |      |      |          |      |          |      |          |           |          |      |           |
| 011b      | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                       |      |             |      |      |      |          |      |          |      |          |           |          |      |           |
| 110b-100b | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                       |      |             |      |      |      |          |      |          |      |          |           |          |      |           |
| 111b      | Undefined                                                                                                                                                                                                                                                                                                                                                                                                                                      |      |             |      |      |      |          |      |          |      |          |           |          |      |           |
| 7:5       | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                      |      |             |      |      |      |          |      |          |      |          |           |          |      |           |
| 4         | <b>PtrInitReq: fifo pointer initialization request.</b> Read; write-1-only; cleared-when-done. Reset: 0. BIOS: See <a href="#">2.9.9.7</a> . 1=The DCT performs transmit and receive fifo pointer initialization. This bit is cleared by hardware after the initialization completes.                                                                                                                                                          |      |             |      |      |      |          |      |          |      |          |           |          |      |           |
| 3         | <b>DccPgSsBusDis: Dcc powergate sourcesynchronous bus disable.</b> Read-write. Reset: 0. BIOS: 0. 1=Disable powergating the ss channel when the Dcc is powergated. 0=Dcc powergate also power-gates ss channel.                                                                                                                                                                                                                                |      |             |      |      |      |          |      |          |      |          |           |          |      |           |
| 2         | <b>GsyncDis: G-sync bus disable.</b> Read-write. Reset: 1. BIOS: See <a href="#">Table 35</a> . 0=Enable the G-sync bus communication between phys and the PLL. 1=G-sync bus is masked.                                                                                                                                                                                                                                                        |      |             |      |      |      |          |      |          |      |          |           |          |      |           |
| 1         | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                      |      |             |      |      |      |          |      |          |      |          |           |          |      |           |
| 0         | <b>ChanVal: DRAM channel valid.</b> Read-write. Reset: 0. BIOS: See <a href="#">2.9.9.7</a> . 1=Communication between the DCT and DRAM phy is enabled and the DCT exits direct response mode. 0=Communication between the DCT and phy is disabled and direct response mode is enabled.                                                                                                                                                         |      |             |      |      |      |          |      |          |      |          |           |          |      |           |

### D18F2x7C\_dct[3:0] DRAM Initialization

Reset: 0000\_0000h. See [2.9.3 \[DCT Configuration Registers\]](#).

For [Ddr3Mode](#), BIOS can directly control the DRAM initialization sequence using this register. To do so, BIOS sets EnDramInit to start DRAM initialization. BIOS should then complete the initialization sequence specified in the appropriate JEDEC specification. After completing the sequence, BIOS clears EnDramInit to complete DRAM initialization. BIOS should not assert LDTSTOP\_L while EnDramInit is set. Setting more than one of the command bits in this register (SendControlWord, SendMrsCmd, and SendAutoRefresh) at a time results in undefined behavior.

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |      |             |     |                            |     |                            |     |                            |     |                            |
|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|-----|----------------------------|-----|----------------------------|-----|----------------------------|-----|----------------------------|
| 31    | <b>EnDramInit: enable DRAM initialization.</b> Read-write. 1=Place the DRAM controller in the BIOS-controlled DRAM initialization mode. The DCT deasserts CKE when this bit is set. BIOS must wait until <a href="#">D18F2x98_dct[3:0][DctAccessDone]</a> = 1 before programming AssertCke=1. BIOS must clear this bit after DRAM initialization is complete. BIOS must not set this bit on a DCT with no attached DIMMs.                                                                                                                                                  |      |             |     |                            |     |                            |     |                            |     |                            |
| 30    | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |      |             |     |                            |     |                            |     |                            |     |                            |
| 29    | <b>SendZQCmd: send ZQ command.</b> Read; write-1-only; cleared-by-hardware. 1=The DCT sends the ZQ calibration command with either all even or all odd chip selects active. The first command targets even chip selects. Subsequent commands alternate between even and odd chip selects. This bit is cleared by the hardware after the command completes. This bit is valid only when EnDramInit=1.                                                                                                                                                                       |      |             |     |                            |     |                            |     |                            |     |                            |
| 28    | <b>AssertCke: assert CKE.</b> Read-write. Setting this bit causes the DCT to assert the CKE pins. This bit cannot be used to deassert the CKE pins.<br>If the link between the DCT and the phy is not connected ( <a href="#">D18F2x78_dct[3:0][PtrInitReq]</a> has not previously been set), then this bit has no effect on the pin state until it is connected with PtrInitReq.                                                                                                                                                                                          |      |             |     |                            |     |                            |     |                            |     |                            |
| 27    | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |      |             |     |                            |     |                            |     |                            |     |                            |
| 26    | <b>SendMrsCmd: send MRS command.</b> Read; write-1-only; cleared-by-hardware.<br>1=The DCT sends the MRS commands defined by the MrsAddress and MrsBank fields of this register to the chip selects defined in <a href="#">D18F2xA8_dct[3:0][MrsCtrlWordCS]</a> . This bit is cleared by hardware after the command completes.                                                                                                                                                                                                                                             |      |             |     |                            |     |                            |     |                            |     |                            |
| 25    | <b>SendAutoRefresh: send auto refresh command.</b> Read; write-1-only; cleared-by-hardware. 1=The DCT sends an auto refresh command. This bit is cleared by hardware after the command completes.                                                                                                                                                                                                                                                                                                                                                                          |      |             |     |                            |     |                            |     |                            |     |                            |
| 24    | <b>DeassertCke: deassert CKE.</b> Read; write-1-only; cleared-by-hardware. Setting this bit causes the DCT to deassert the CKE pins. This bit cannot be used to assert the CKE pins. If the link between the DCT and the phy is not connected ( <a href="#">D18F2x78_dct[3:0][PtrInitReq]</a> has not previously been set), then this bit has no effect on the pin state until it is connected with PtrInitReq. DeassertCke register bit is cleared by hardware immediately after the register write completes.                                                            |      |             |     |                            |     |                            |     |                            |     |                            |
| 23:22 | <b>MrsChipSel: MRS command chip select.</b> Read-write. Specifies which DRAM chip select is used for MRS commands. Defined only if ( $\sim$ EnDramInit   $\sim$ <a href="#">D18F2x90_dct[3:0][UnbuffDimm]</a> ); otherwise MRS commands are sent to all chip selects. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>MRS command is sent to CS0</td></tr> <tr> <td>01b</td><td>MRS command is sent to CS1</td></tr> <tr> <td>10b</td><td>MRS command is sent to CS2</td></tr> <tr> <td>11b</td><td>MRS command is sent to CS3</td></tr> </table> | Bits | Description | 00b | MRS command is sent to CS0 | 01b | MRS command is sent to CS1 | 10b | MRS command is sent to CS2 | 11b | MRS command is sent to CS3 |
| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |      |             |     |                            |     |                            |     |                            |     |                            |
| 00b   | MRS command is sent to CS0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |      |             |     |                            |     |                            |     |                            |     |                            |
| 01b   | MRS command is sent to CS1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |      |             |     |                            |     |                            |     |                            |     |                            |
| 10b   | MRS command is sent to CS2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |      |             |     |                            |     |                            |     |                            |     |                            |
| 11b   | MRS command is sent to CS3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |      |             |     |                            |     |                            |     |                            |     |                            |
| 21:18 | <b>MrsBank[3:0]: bank address for MRS commands.</b> Read-write. Specifies the data driven on the DRAM bank pins for MRS commands. MrsBank[3] is Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                  |      |             |     |                            |     |                            |     |                            |     |                            |
| 17:0  | <b>MrsAddress[17:0]: address for MRS commands.</b> Read-write. Specifies the data driven on the DRAM address pins for MRS commands.                                                                                                                                                                                                                                                                                                                                                                                                                                        |      |             |     |                            |     |                            |     |                            |     |                            |

**D18F2x80\_dct[3:0] DRAM Bank Address Mapping**

IF (D18F2x118[LockDramCfg]) THEN Read-only. ELSE Read-write. ENDIF. Reset: 0000\_0000h. See 2.9.3 [DCT Configuration Registers]. These fields specify DIMM configuration information. These fields are required to be programmed based on the DRAM device size and with information of the DIMM. Table 140 shows the bit numbers for each position.

| Bits  | Description                              |
|-------|------------------------------------------|
| 31:16 | Reserved.                                |
| 15:8  | Reserved.                                |
| 7:4   | <b>DimmAddrMap1: DIMM 1 address map.</b> |
| 3:0   | <b>DimmAddrMap0: DIMM 0 address map.</b> |

**Table 140: DDR3 DRAM Address Mapping**

| Bits            | CS Size | Device size,<br>width | Bank |    |    | Address |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|-----------------|---------|-----------------------|------|----|----|---------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
|                 |         |                       | 2    | 1  | 0  |         | 15 | 14 | 13 | 12 | 11 | 10 | 9  | 8  | 7  | 6  | 5  | 4  | 3  | 2  | 1  | 0  |
| 0000b           |         | Reserved              |      |    |    | Row     |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|                 |         |                       |      |    |    | Col     |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| 0001b           | 256MB   | 512Mb, x16            | 15   | 14 | 13 | Row     | x  | x  | x  | x  | 17 | 16 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 |
|                 |         |                       |      |    |    | Col     | x  | x  | x  | x  | x  | AP | 12 | 11 | 10 | 9  | 8  | 7  | 6  | 5  | 4  | 3  |
| 0010b           | 512MB   | 512Mb, x8<br>1Gb, x16 | 15   | 14 | 13 | Row     | x  | x  | x  | 17 | 16 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 |
|                 |         |                       |      |    |    | Col     | x  | x  | x  | x  | x  | AP | 12 | 11 | 10 | 9  | 8  | 7  | 6  | 5  | 4  | 3  |
| 0011b           |         | Reserved              |      |    |    | Row     |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|                 |         |                       |      |    |    | Col     |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| 0100b           |         | Reserved              |      |    |    | Row     |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|                 |         |                       |      |    |    | Col     |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| 0101b           | 1GB     | 1Gb, x8<br>2Gb, x16   | 15   | 14 | 13 | Row     | x  | x  | 17 | 16 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 |
|                 |         |                       |      |    |    | Col     | x  | x  | x  | x  | x  | AP | 12 | 11 | 10 | 9  | 8  | 7  | 6  | 5  | 4  | 3  |
| 0110b           |         | Reserved              |      |    |    | Row     |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|                 |         |                       |      |    |    | Col     |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| 0111b           | 2GB     | 2Gb, x8<br>4Gb, x16   | 15   | 14 | 13 | Row     | x  | 17 | 16 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 |
|                 |         |                       |      |    |    | Col     | x  | x  | x  | x  | x  | AP | 12 | 11 | 10 | 9  | 8  | 7  | 6  | 5  | 4  | 3  |
| 1000b           |         | Reserved              |      |    |    | Row     |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|                 |         |                       |      |    |    | Col     |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| 1001b           |         | Reserved              |      |    |    | Row     |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|                 |         |                       |      |    |    | Col     |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| 1010b           | 4GB     | 4Gb, x8<br>8Gb, x16   | 15   | 14 | 13 | Row     | 17 | 16 | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 |
|                 |         |                       |      |    |    | Col     | x  | x  | x  | x  | x  | AP | 12 | 11 | 10 | 9  | 8  | 7  | 6  | 5  | 4  | 3  |
| 1011b           | 8GB     | 8Gb, x8               | 16   | 15 | 14 | Row     | 17 | 32 | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 |
|                 |         |                       |      |    |    | Col     | x  | x  | x  | x  | 13 | AP | 12 | 11 | 10 | 9  | 8  | 7  | 6  | 5  | 4  | 3  |
| 1111b-<br>1100b |         | Reserved              |      |    |    | Row     |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|                 |         |                       |      |    |    | Col     |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |

**D18F2x84\_dct[3:0] DRAM MRS**

Reset: 0000\_0005h. See 2.9.3 [DCT Configuration Registers].

| Bits                          | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                               |                                             |                          |             |     |                      |         |                                  |    |    |    |                                 |    |    |    |                                          |    |    |    |          |    |    |    |                                    |    |    |    |                                             |
|-------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|---------------------------------------------|--------------------------|-------------|-----|----------------------|---------|----------------------------------|----|----|----|---------------------------------|----|----|----|------------------------------------------|----|----|----|----------|----|----|----|------------------------------------|----|----|----|---------------------------------------------|
| 31:24                         | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                               |                                             |                          |             |     |                      |         |                                  |    |    |    |                                 |    |    |    |                                          |    |    |    |          |    |    |    |                                    |    |    |    |                                             |
| 23                            | <p><b>PchgPDMoSel: precharge power down mode select.</b> Read-write. BIOS: 1. Specifies how a chip select enters and exits power down mode. This mode is enabled by <a href="#">D18F2x94_dct[3:0][PowerDownEn]</a> and its behavior varies based on the setting of <a href="#">D18F2x94_dct[3:0][PowerDownMode]</a> and <a href="#">MR0[PPD]</a> in <a href="#">D18F2x2E8_dct[3:0]_mp[1:0][MxMr0]</a>.</p> <table><tr><th><a href="#">PowerDownMode</a></th><th><a href="#">PchgPDMoSel</a></th><th><a href="#">MR0[PPD]</a></th><th>Description</th></tr><tr><td>0b</td><td>0b</td><td>0b</td><td>Full channel slow exit (DLL off)</td></tr><tr><td>0b</td><td>0b</td><td>1b</td><td>Full channel fast exit (DLL on)</td></tr><tr><td>0b</td><td>1b</td><td>xb</td><td>Full channel dynamic fast exit/slow exit</td></tr><tr><td>1b</td><td>0b</td><td>0b</td><td>Reserved</td></tr><tr><td>1b</td><td>0b</td><td>1b</td><td>Partial channel fast exit (DLL on)</td></tr><tr><td>1b</td><td>1b</td><td>xb</td><td>Partial channel dynamic fast exit/slow exit</td></tr></table> <p>See <a href="#">D18F2x248_dct[3:0]_mp[1:0][Txpdll, Txp]</a>. In dynamic fast exit/slow exit power down mode, the DCT dynamically issues MRS command(s) to the DRAM to specify the powerdown mode; the DCT specifies fast exit mode when chip selects on one of the CKEs has recently been active; it specifies deep power down when chip selects on all CKEs have been idle. PchgPDMoSel=0 &amp;&amp; MR0[PPD]=1 fast exit modes are reserved if S3 is also supported .</p> | <a href="#">PowerDownMode</a> | <a href="#">PchgPDMoSel</a>                 | <a href="#">MR0[PPD]</a> | Description | 0b  | 0b                   | 0b      | Full channel slow exit (DLL off) | 0b | 0b | 1b | Full channel fast exit (DLL on) | 0b | 1b | xb | Full channel dynamic fast exit/slow exit | 1b | 0b | 0b | Reserved | 1b | 0b | 1b | Partial channel fast exit (DLL on) | 1b | 1b | xb | Partial channel dynamic fast exit/slow exit |
| <a href="#">PowerDownMode</a> | <a href="#">PchgPDMoSel</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <a href="#">MR0[PPD]</a>      | Description                                 |                          |             |     |                      |         |                                  |    |    |    |                                 |    |    |    |                                          |    |    |    |          |    |    |    |                                    |    |    |    |                                             |
| 0b                            | 0b                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 0b                            | Full channel slow exit (DLL off)            |                          |             |     |                      |         |                                  |    |    |    |                                 |    |    |    |                                          |    |    |    |          |    |    |    |                                    |    |    |    |                                             |
| 0b                            | 0b                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 1b                            | Full channel fast exit (DLL on)             |                          |             |     |                      |         |                                  |    |    |    |                                 |    |    |    |                                          |    |    |    |          |    |    |    |                                    |    |    |    |                                             |
| 0b                            | 1b                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | xb                            | Full channel dynamic fast exit/slow exit    |                          |             |     |                      |         |                                  |    |    |    |                                 |    |    |    |                                          |    |    |    |          |    |    |    |                                    |    |    |    |                                             |
| 1b                            | 0b                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 0b                            | Reserved                                    |                          |             |     |                      |         |                                  |    |    |    |                                 |    |    |    |                                          |    |    |    |          |    |    |    |                                    |    |    |    |                                             |
| 1b                            | 0b                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 1b                            | Partial channel fast exit (DLL on)          |                          |             |     |                      |         |                                  |    |    |    |                                 |    |    |    |                                          |    |    |    |          |    |    |    |                                    |    |    |    |                                             |
| 1b                            | 1b                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | xb                            | Partial channel dynamic fast exit/slow exit |                          |             |     |                      |         |                                  |    |    |    |                                 |    |    |    |                                          |    |    |    |          |    |    |    |                                    |    |    |    |                                             |
| 22:2                          | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                               |                                             |                          |             |     |                      |         |                                  |    |    |    |                                 |    |    |    |                                          |    |    |    |          |    |    |    |                                    |    |    |    |                                             |
| 1:0                           | <p><b>BurstCtrl: burst length control.</b> Read-write. BIOS: 01b. Specifies the number of sequential beats of DQ related to one read or write command. Requests from the processor are always 64-byte-length. Requests generated by <a href="#">D18F2x250_dct[3:0]</a> are always 64-byte-length. Requests from GMC may be 32-byte or 64-byte-length. Software must ensure that GMC requests are disabled to configure the controller and drams for 8-beat burst length (e.g. during training). If this mode is changed, software must issue a mode-register set command to MR0 of the drams to place them in the same mode.</p> <table><tr><th><a href="#">Bits</a></th><th><a href="#">Description</a></th></tr><tr><td>00b</td><td>8 beats</td></tr><tr><td>01b</td><td>Dynamic 4 or 8 beats</td></tr><tr><td>11b-10b</td><td>Reserved</td></tr></table>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <a href="#">Bits</a>          | <a href="#">Description</a>                 | 00b                      | 8 beats     | 01b | Dynamic 4 or 8 beats | 11b-10b | Reserved                         |    |    |    |                                 |    |    |    |                                          |    |    |    |          |    |    |    |                                    |    |    |    |                                             |
| <a href="#">Bits</a>          | <a href="#">Description</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                               |                                             |                          |             |     |                      |         |                                  |    |    |    |                                 |    |    |    |                                          |    |    |    |          |    |    |    |                                    |    |    |    |                                             |
| 00b                           | 8 beats                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                               |                                             |                          |             |     |                      |         |                                  |    |    |    |                                 |    |    |    |                                          |    |    |    |          |    |    |    |                                    |    |    |    |                                             |
| 01b                           | Dynamic 4 or 8 beats                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                               |                                             |                          |             |     |                      |         |                                  |    |    |    |                                 |    |    |    |                                          |    |    |    |          |    |    |    |                                    |    |    |    |                                             |
| 11b-10b                       | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                               |                                             |                          |             |     |                      |         |                                  |    |    |    |                                 |    |    |    |                                          |    |    |    |          |    |    |    |                                    |    |    |    |                                             |

### **D18F2x88\_dct[3:0] DRAM Timing Low**

Reset: 3F00\_0000h. See [2.9.3 \[DCT Configuration Registers\]](#).

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |     |     |     |             |     |             |     |             |     |             |     |             |     |             |
|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|-----|-------------|-----|-------------|-----|-------------|-----|-------------|-----|-------------|-----|-------------|
| 31:30 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |     |     |     |             |     |             |     |             |     |             |     |             |     |             |
| 29:24 | <p><b>MemClkDis: MEMCLK disable.</b> Read-write. 1=Disable the MEMCLK. 0=Enable MEMCLK. All enabled clocks should be 0; all no-connect and unused clocks should be 1.</p> <table> <tr> <th>Bit</th><th>Pad</th></tr> <tr> <td>[0]</td><td>MEMCLK_H[0]</td></tr> <tr> <td>[1]</td><td>MEMCLK_H[1]</td></tr> <tr> <td>[2]</td><td>MEMCLK_H[2]</td></tr> <tr> <td>[3]</td><td>MEMCLK_H[3]</td></tr> <tr> <td>[4]</td><td>MEMCLK_H[4]</td></tr> <tr> <td>[5]</td><td>MEMCLK_H[5]</td></tr> </table> | Bit | Pad | [0] | MEMCLK_H[0] | [1] | MEMCLK_H[1] | [2] | MEMCLK_H[2] | [3] | MEMCLK_H[3] | [4] | MEMCLK_H[4] | [5] | MEMCLK_H[5] |
| Bit   | Pad                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |     |     |     |             |     |             |     |             |     |             |     |             |     |             |
| [0]   | MEMCLK_H[0]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |     |     |     |             |     |             |     |             |     |             |     |             |     |             |
| [1]   | MEMCLK_H[1]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |     |     |     |             |     |             |     |             |     |             |     |             |     |             |
| [2]   | MEMCLK_H[2]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |     |     |     |             |     |             |     |             |     |             |     |             |     |             |
| [3]   | MEMCLK_H[3]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |     |     |     |             |     |             |     |             |     |             |     |             |     |             |
| [4]   | MEMCLK_H[4]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |     |     |     |             |     |             |     |             |     |             |     |             |     |             |
| [5]   | MEMCLK_H[5]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |     |     |     |             |     |             |     |             |     |             |     |             |     |             |
| 23:0  | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |     |     |     |             |     |             |     |             |     |             |     |             |     |             |



**D18F2x8C\_dct[3:0] DRAM Timing High**

See 2.9.3 [DCT Configuration Registers].

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                          |      |             |     |                     |     |          |     |              |     |              |
|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|-----|---------------------|-----|----------|-----|--------------|-----|--------------|
| 31:19 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                            |      |             |     |                     |     |          |     |              |     |              |
| 18    | <b>DisAutoRefresh: disable automatic refresh.</b> Read-write. Reset: 0. BIOS: See 2.9.9.4. 1=Automatic refresh is disabled.                                                                                                                                                                                                                                                                          |      |             |     |                     |     |          |     |              |     |              |
| 17:16 | <b>Tref: refresh rate.</b> Read-write. Reset: 0. BIOS: See 2.9.9.3. This specifies the average time between refresh requests to all DRAM devices.<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>Undefined behavior.</td></tr> <tr> <td>01b</td><td>Reserved</td></tr> <tr> <td>10b</td><td>Every 7.8 us</td></tr> <tr> <td>11b</td><td>Every 3.9 us</td></tr> </table> | Bits | Description | 00b | Undefined behavior. | 01b | Reserved | 10b | Every 7.8 us | 11b | Every 3.9 us |
| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                          |      |             |     |                     |     |          |     |              |     |              |
| 00b   | Undefined behavior.                                                                                                                                                                                                                                                                                                                                                                                  |      |             |     |                     |     |          |     |              |     |              |
| 01b   | Reserved                                                                                                                                                                                                                                                                                                                                                                                             |      |             |     |                     |     |          |     |              |     |              |
| 10b   | Every 7.8 us                                                                                                                                                                                                                                                                                                                                                                                         |      |             |     |                     |     |          |     |              |     |              |
| 11b   | Every 3.9 us                                                                                                                                                                                                                                                                                                                                                                                         |      |             |     |                     |     |          |     |              |     |              |
| 15:0  | Reserved.                                                                                                                                                                                                                                                                                                                                                                                            |      |             |     |                     |     |          |     |              |     |              |

**D18F2x90\_dct[3:0] DRAM Configuration Low**

See 2.9.3 [DCT Configuration Registers].

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |      |             |    |          |       |                          |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|----|----------|-------|--------------------------|
| 31:28 | <b>IdleCycLimit: idle cycle limit.</b> Read-write. Reset: 8h. BIOS: 8h. Specifies the number of MEMCLK cycles an idle page is open before it is closed if DynPageCloseEn=0. This field is ignored if DynPageCloseEn=1.<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>0h</td><td>8 clocks</td></tr> <tr> <td>Fh-1h</td><td>&lt;IdleCycLimit&gt;*16 clocks</td></tr> </table>                                                                                                                                  | Bits | Description | 0h | 8 clocks | Fh-1h | <IdleCycLimit>*16 clocks |
| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |      |             |    |          |       |                          |
| 0h    | 8 clocks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |      |             |    |          |       |                          |
| Fh-1h | <IdleCycLimit>*16 clocks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |      |             |    |          |       |                          |
| 27    | <b>DisDllShutdownSR: disable DLL shutdown in self-refresh mode.</b> Read-write. Reset: 1. 1=Disable the power saving features of shutting down DDR phy DLLs during DRAM self refresh and memory P-states. 0=Shutdown DLLs during DRAM self refresh and allow memory P-state transitions.<br>Setting this bit does not effect the current memory P-state. Setting this bit for the DCT master channel of a DCT pair controls both DCTs of the pair. Setting this bit for the DCT which is not the master channel has no effect. |      |             |    |          |       |                          |
| 26    | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |      |             |    |          |       |                          |
| 25    | <b>PendRefPaybackS3En: pending refresh payback S3 enable.</b> Read-write. Reset: 0. BIOS: 1. Specifies the S3 refresh payback behavior when PendRefPayback=0. 1=Pending refreshes are paid back on S3 entry. 0=Pending refreshes are not paid back on S3 entry.                                                                                                                                                                                                                                                                |      |             |    |          |       |                          |
| 24    | <b>StagRefEn: Stagger Refresh Enable.</b> Read-write. Reset: 0. BIOS: 1. 1=The DRAM controller arbitrates refreshes among chip selects based on the Tstag value. See D18F2x228_dct[3:0]. 0=DCT arbitrates among chip selects using the Trfc value.                                                                                                                                                                                                                                                                             |      |             |    |          |       |                          |
| 23    | <b>ForceAutoPchg: force auto precharging.</b> Read-write. Reset: 0. BIOS: See 2.9.9.4. 1=Force auto-precharge cycles with every read or write command.                                                                                                                                                                                                                                                                                                                                                                         |      |             |    |          |       |                          |

| 22:21       | <p><b>IdleCycLowLimit: idle cycle low limit.</b> Read-write. Reset: 0. Specifies the number of MEMCLK cycles a page is allowed to be open before it may be closed by the dynamic page close logic. This field is ignored if <a href="#">D18F2x90_dct[3:0][DynPageCloseEn]</a> = 0.</p> <table> <tr> <th><u>Bits</u></th><th><u>Description</u></th></tr> <tr> <td>00b</td><td>16 clocks</td></tr> <tr> <td>01b</td><td>32 clocks</td></tr> <tr> <td>10b</td><td>64 clocks</td></tr> <tr> <td>11b</td><td>96 clocks</td></tr> </table> | <u>Bits</u> | <u>Description</u> | 00b | 16 clocks | 01b | 32 clocks | 10b | 64 clocks | 11b | 96 clocks |
|-------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|--------------------|-----|-----------|-----|-----------|-----|-----------|-----|-----------|
| <u>Bits</u> | <u>Description</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |             |                    |     |           |     |           |     |           |     |           |
| 00b         | 16 clocks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |             |                    |     |           |     |           |     |           |     |           |
| 01b         | 32 clocks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |             |                    |     |           |     |           |     |           |     |           |
| 10b         | 64 clocks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |             |                    |     |           |     |           |     |           |     |           |
| 11b         | 96 clocks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |             |                    |     |           |     |           |     |           |     |           |
| 20          | <p><b>DynPageCloseEn: dynamic page close enable.</b> Read-write. Reset: 0. See <a href="#">2.9.9.4 [DCT Specific Configuration]</a>.<br/>1=The DRAM controller dynamically determines when to close open pages based on the history of that particular page and <a href="#">D18F2x90_dct[3:0][IdleCycLowLimit]</a>. 0=Any open pages not auto-pre-charged by the DRAM controller are automatically closed after IdleCycLimit clocks of inactivity.</p>                                                                                |             |                    |     |           |     |           |     |           |     |           |
| 19          | <p><b>DimmEccEn: DIMM ECC enable.</b> Read-write. Reset: 0. 1=ECC checking is capable of being enabled for all DIMMs on the DRAM controller by <a href="#">D18F3x44[DramEccEn]</a>. This bit should not be set unless all populated DIMMs support ECC check bits. 0=ECC checking is disabled on the DRAM controller.</p>                                                                                                                                                                                                              |             |                    |     |           |     |           |     |           |     |           |
| 18          | <p><b>PendRefPayback: pending refresh payback.</b> Read-write. Reset: 0. BIOS: 0. 1=The DRAM controller executes all pending refresh commands before entering the self refresh state. 0=The controller enters the self refresh state regardless of the number of pending refreshes; applies to any self refresh entry if <a href="#">PendRefPaybackS3En</a>=0, else any non-S3 self refresh entry.</p>                                                                                                                                |             |                    |     |           |     |           |     |           |     |           |
| 17          | <p><b>EnterSelfRef: enter self refresh command.</b> Read, write-1-only; cleared-by-hardware. Reset: 0. 1=The DRAM controller places the DRAMs into self refresh mode. The DRAM interface is tristated 1 MEMCLK after the self refresh command is issued to the DRAMs. Once entered, the DRAM interface must remain in self refresh mode for a minimum of 5 MEMCLKs. This bit is read as a 1 while the enter-self-refresh command is executing; it is read as 0 at all other times.</p>                                                |             |                    |     |           |     |           |     |           |     |           |
| 16          | <p><b>UnbuffDimm: unbuffered DIMM.</b> Read-write or read-only, depending on the product. Reset: Product-specific. BIOS: 1. 1=The DRAM controller is connected to unbuffered DIMMs. 0=Reserved.</p>                                                                                                                                                                                                                                                                                                                                   |             |                    |     |           |     |           |     |           |     |           |
| 15:12       | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |             |                    |     |           |     |           |     |           |     |           |
| 11          | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |             |                    |     |           |     |           |     |           |     |           |
| 10          | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |             |                    |     |           |     |           |     |           |     |           |
| 9           | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |             |                    |     |           |     |           |     |           |     |           |
| 8           | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |             |                    |     |           |     |           |     |           |     |           |
| 7           | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |             |                    |     |           |     |           |     |           |     |           |
| 6           | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |             |                    |     |           |     |           |     |           |     |           |

|   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|---|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 5 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 4 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 3 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 2 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 1 | <b>ExitSelfRef: exit self refresh (after suspend to RAM or for DRAM training) command.</b> Read, write-1-only; cleared-by-hardware. Reset: 0. Writing a 1 to this bit causes the DRAM controller to bring the DRAMs out of self refresh mode. It also causes the DRAM controller to issue ZQCL and MRS MR0 commands. This command should be executed by BIOS when returning from the suspend to RAM state, after the DRAM controller configuration registers are properly initialized, or when self refresh is used during DRAM training. This bit is read as a 1 while the exit-self-refresh command is executing; it is read as 0 at all other times. This bit should not be set if the DCT is disabled. |
| 0 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |

### D18F2x94\_dct[3:0] DRAM Configuration High

See 2.9.3 [DCT Configuration Registers].

| Bits   | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |      |             |    |                                                  |        |                                                                      |
|--------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|----|--------------------------------------------------|--------|----------------------------------------------------------------------|
| 31     | <b>DphyMemPsSelEn.</b> Read-write. Reset: 1h. BIOS: 0. 1=The DCT uses D18F1x10C[MemPsSel] to configure DctOffset[24] to the phy while the value that software writes to DctOffset[24] is ignored. 0=Software determines DctOffset[24]. BIOS must clear this bit for proper operation.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |      |             |    |                                                  |        |                                                                      |
| 30:29  | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |      |             |    |                                                  |        |                                                                      |
| 28:24  | <b>DcqBypassMax: DRAM controller queue bypass maximum.</b> Read-write. Reset: 0h. BIOS: 2.9.9.4. The DRAM controller arbiter normally allows transactions to pass other transactions in order to optimize DRAM bandwidth. This field specifies the maximum number of times that the oldest memory-access request in the DRAM controller queue may be bypassed before the arbiter decision is overridden and the oldest memory-access request is serviced instead.<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>0h</td><td>No bypass; the oldest request is never bypassed.</td></tr> <tr> <td>1Fh-1h</td><td>The oldest request may be bypassed no more than &lt;DcqBypassMax&gt; time.</td></tr> </table>                                                                                        | Bits | Description | 0h | No bypass; the oldest request is never bypassed. | 1Fh-1h | The oldest request may be bypassed no more than <DcqBypassMax> time. |
| Bits   | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |      |             |    |                                                  |        |                                                                      |
| 0h     | No bypass; the oldest request is never bypassed.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |      |             |    |                                                  |        |                                                                      |
| 1Fh-1h | The oldest request may be bypassed no more than <DcqBypassMax> time.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |      |             |    |                                                  |        |                                                                      |
| 23     | <b>ProcOdtDis: processor on-die termination disable.</b> Read-write. Reset: 0h. 1=The processor-side on-die termination is disabled. 0=Processor-side on-die termination enabled. Changes to this bit must be performed prior to setting MemClkFreqVal.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |      |             |    |                                                  |        |                                                                      |
| 22     | <b>BankSwizzleMode: bank swizzle mode.</b> Read-write. Reset: 0. BIOS: 2.9.9.4. 1=Remaps the DRAM device bank address bits as a function of normalized physical address bits. Each of the bank address bits, as specified in D18F2x80_dct[3:0], are remapped as follows: <ul style="list-style-type: none"> <li>Define X as a bank address bit (e.g., X=15 if the bank bit is specified to be address bit 15).</li> <li>Define S(n) as the state of address bit n (0 or 1) and B as the remapped bank address bit. Then, Ddr3Mode:<br/> <math display="block">B = S(X) \wedge S(X + 3) \wedge S(X + 6); \text{ for an 8-bank DRAM.}</math> For example, encoding 02h of Table 140 would be remapped from Bank[2:0]={A15, A14, A13} to the following: Bank[2:0] = {A15^A18^A21, A14^A17^A20, A13^A16^A19}.</li> </ul> |      |             |    |                                                  |        |                                                                      |

|    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 21 | <b>FreqChgInProg: frequency change in progress.</b> Read-only. Reset: 0. 1=A MEMCLK frequency change is in progress. The DDR phy asserts this bit when it is in the process of locking the PLL. BIOS should not program the phy registers while this bit is set. 0=DRAM-interface commands can be sent to the phy.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| 20 | <b>SlowAccessMode: slow access mode (a.k.a. 2T mode).</b> Read-write. Reset: 0. 1=One additional MEMCLK of setup time is provided on all DRAM address and control signals (not including CS, CKE, and ODT); i.e., these signals are driven for two MEMCLK cycles rather than one. 0=DRAM address and control signals are driven for one MEMCLK cycle. 2T mode may be needed in order to meet electrical requirements of certain DIMM speed and loading configurations. If memory P-states are enabled then BIOS must set this bit if 2T timing is recommended for either memory P-state.                                                                                                                                                                                                                                                                                                                                                                                |
| 19 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 18 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 17 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 16 | <b>PowerDownMode: power down mode.</b> Read-write. Reset: 0. BIOS: 1. Specifies how a chip select or group of chip selects enters power down mode when enabled by <a href="#">D18F2x94_dct[3:0][PowerDownEn]</a> . A chip select enters power down mode when the DCT deasserts the CKE pin. The command and address signals tristate one MEMCLK after CKE deasserts. The DCT behavior varies based on the setting of <a href="#">D18F2x84_dct[3:0][PchgPDModeSel]</a> . See also <a href="#">Table 139 [DIMM, Chip Select, and Register Mapping]</a> .<br>0=Channel CKE control mode; the DRAM channel is placed in power down mode when all chip selects associated with the channel are idle; CKE pins for the channel operate in lock step in terms of placing the channel in power down mode.<br>1=Chip select CKE control mode; the chip select group controlled by a CKE pin is placed in power down mode when all chip selects associated with the pin are idle. |
| 15 | <b>PowerDownEn: power down mode enable.</b> Read-write. Reset: 0. BIOS: 1.<br>1=Power down mode is enabled. Only precharge power down mode is supported, not active power down mode. See PowerDownMode, <a href="#">D18F2x84_dct[3:0][PchgPDModeSel]</a> , <a href="#">D18F2xA8_dct[3:0][PrtlChPDEnhEn]</a> , <a href="#">AggrPDEn</a> , <a href="#">PDPhyPSDis</a> , and <a href="#">D18F2x248_dct[3:0]_mp[1:0][PchgPDEnDelay]</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 14 | <b>DisDramInterface: disable the DRAM interface.</b> Read-write. Reset: 0. 1=The DRAM controller is disabled and the DRAM interface is placed into a low power state. This bit must be set if there are no DIMMs connected to the DCT.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 13 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 12 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |

| 11:10 | <b>ZqcsInterval: ZQ calibration short interval.</b> Read-write. Reset: 00b. This field specifies the programmable interval for the controller to send out the DRAM ZQ calibration short command.<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>ZQ calibration short command is disabled</td></tr> <tr> <td>01b</td><td>64 ms</td></tr> <tr> <td>10b</td><td>128 ms</td></tr> <tr> <td>11b</td><td>256 ms</td></tr> </table> | Bits | Description | 00b | ZQ calibration short command is disabled | 01b | 64 ms | 10b | 128 ms | 11b | 256 ms |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|-----|------------------------------------------|-----|-------|-----|--------|-----|--------|
| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                               |      |             |     |                                          |     |       |     |        |     |        |
| 00b   | ZQ calibration short command is disabled                                                                                                                                                                                                                                                                                                                                                                                                                  |      |             |     |                                          |     |       |     |        |     |        |
| 01b   | 64 ms                                                                                                                                                                                                                                                                                                                                                                                                                                                     |      |             |     |                                          |     |       |     |        |     |        |
| 10b   | 128 ms                                                                                                                                                                                                                                                                                                                                                                                                                                                    |      |             |     |                                          |     |       |     |        |     |        |
| 11b   | 256 ms                                                                                                                                                                                                                                                                                                                                                                                                                                                    |      |             |     |                                          |     |       |     |        |     |        |
| 9:8   | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                 |      |             |     |                                          |     |       |     |        |     |        |
| 7     | <b>MemClkFreqVal: memory clock frequency valid.</b> Read-write. Reset: 0. System BIOS should set this bit after setting up <a href="#">D18F2x94_dct[3:0][MemClkFreq]</a> to the proper value. This indicates to the DRAM controller that it may start driving internal channel clocks corresponding to MEMCLK to the proper frequency. This bit should not be set if the DCT is disabled. BIOS must change each DCT's operating frequency in order.       |      |             |     |                                          |     |       |     |        |     |        |
| 6:5   | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                 |      |             |     |                                          |     |       |     |        |     |        |
| 4:0   | <b>MemClkFreq: memory clock frequency.</b> Read-write. Reset: 000b.<br>Specifies the frequency and rate of the DRAM interface (MEMCLK). See: <a href="#">Table 141 [Valid Values for Memory Clock Frequency Value Definition]</a> . The rate is twice the frequency. See <a href="#">D18F5x84[DdrMaxRate]</a> and <a href="#">D18F5x84[DdrMaxRateEnf]</a> . See MemClkFreqVal.                                                                            |      |             |     |                                          |     |       |     |        |     |        |

**Table 141:** [Valid Values](#) for Memory Clock Frequency Value Definition

| Bits    | Description           |
|---------|-----------------------|
| 01h-00h | Reserved              |
| 02h     | 200 MHz. (400 MT/s)   |
| 03h     | Reserved              |
| 04h     | 333 MHz. (667 MT/s)   |
| 05h     | Reserved              |
| 06h     | 400 MHz. (800 MT/s)   |
| 09h-07h | Reserved              |
| 0Ah     | 533 MHz. (1066 MT/s)  |
| 0Dh-0Bh | Reserved              |
| 0Eh     | 667 MHz. (1333 MT/s)  |
| 11h-0Fh | Reserved              |
| 12h     | 800 MHz. (1600 MT/s)  |
| 15h-13h | Reserved              |
| 16h     | 933 MHz. (1866 MT/s)  |
| 1Fh-17h | Reserved              |
| 19h     | 1050 MHz. (2100 MT/s) |
| 1Ah     | 1066 MHz. (2133 MT/s) |
| 1Fh     | 1200 MHz. (2400 MT/s) |

**D18F2x98\_dct[3:0] DRAM Controller Additional Data Offset**

Reset: 8000\_0000h. See 2.9.3 [DCT Configuration Registers].

Each DCT includes an array of registers that are used primarily to control DRAM-interface electrical parameters. Access to these registers is accomplished as follows:

- Reads (without auto-increment):

1. Write the register number to [D18F2x98\\_dct\[3:0\]\[DctOffset\]](#) with [D18F2x98\\_dct\[1:0\]\[DctAccessWrite, DctOffsetAutoIncEn\]](#)={0,0}.
2. Read the register contents from [D18F2x9C\\_dct\[3:0\]](#).

Writes (without auto-increment):

1. Write all 32 bits of register data to [D18F2x9C\\_dct\[3:0\]](#) (individual byte writes are not supported).
2. Write the register number to [D18F2x98\\_dct\[3:0\]\[DctOffset\]](#) with [D18F2x98\\_dct\[3:0\]\[DctAccessWrite, DctOffsetAutoIncEn\]](#)={1,0}.
  - The data will be delivered to the phy similar to a posted memory-write, and the write will complete without any further action. However, to ensure that the contents of the array register write have been delivered to the phy, software issues a subsequent configuration register read or write to any register in the northbridge. For example, reading [D18F2x98\\_dct\[3:0\]](#) will accomplish this.

- Reads (with auto-increment):

1. Write the first register number to [D18F2x98\\_dct\[3:0\]\[DctOffset\]](#) with [D18F2x98\\_dct\[1:0\]\[DctAccessWrite, DctOffsetAutoIncEn\]](#)={0,1}.
2. Read the register contents from [D18F2x9C\\_dct\[3:0\]](#).
3. Repeat step 2 as needed for each additional array register read.
4. Program [D18F2x98\\_dct\[3:0\]\[DctOffsetAutoIncEn\]](#)=0.

Writes (with auto-increment):

1. Write the first register number to [D18F2x98\\_dct\[3:0\]\[DctOffset\]](#) with [D18F2x98\\_dct\[3:0\]\[DctAccessWrite, DctOffsetAutoIncEn\]](#)={1,1}.
2. Write all 32 bits of register data to [D18F2x9C\\_dct\[3:0\]](#).
3. Repeat step 2 as needed for each additional array register write.
4. Program [D18F2x98\\_dct\[3:0\]\[DctOffsetAutoIncEn\]](#)=0.

| Bits | Description                                                                                                                                                                                                                                                                                                                                                                                               |
|------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31   | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                 |
| 30   | <b>DctAccessWrite: DRAM controller read/write select.</b> Read-write. 0=Specifies a read access. 1=Specifies a write access.                                                                                                                                                                                                                                                                              |
| 29   | <b>DctOffsetAutoIncEn: DCT offset auto-increment enable.</b> Read-write. 1=Specifies that subsequent accesses will cause the DCT to increment the DctOffset field by one after the access. When in this mode, the DCT will generate accesses to the phy registers with sequential accesses only to the data port ( <a href="#">D18F2x9C_dct[3:0]</a> ). 0=DctOffset is not incremented after each access. |
| 28:0 | <b>DctOffset: DRAM controller offset.</b> Read-write.                                                                                                                                                                                                                                                                                                                                                     |

**D18F2x9C\_dct[3:0] DRAM Controller Additional Data Port**

See [D18F2x98\\_dct\[3:0\]](#) for register access information. See [2.9.3 \[DCT Configuration Registers\]](#). Address: [D18F2x98\\_dct\[3:0\]\[DctOffset\]](#).

| Bits | Description  |
|------|--------------|
| 31:0 | <b>Data.</b> |

**D18F2x9C\_x00[F,3:0]0\_0009\_dct[3:0] High Addr Mode**

Cold reset: 0000\_0000h. See [2.9.4.1](#) for chiplet to pad mapping.

Table 142: [Index Mapping](#) for [D18F2x9C\\_x00\[F,3:0\]0\\_0009\\_dct\[3:0\]](#)

| Address Bits                             | Valid Values | Name              |
|------------------------------------------|--------------|-------------------|
| <a href="#">D18F2x98_dct[3:0][23:20]</a> | [3:0]        | CAD chiplet       |
| <a href="#">D18F2x98_dct[3:0][23:20]</a> | Fh           | CAD chiplet [3:0] |

| Bits | Description                                                                                                                     |
|------|---------------------------------------------------------------------------------------------------------------------------------|
| 31:1 | Reserved.                                                                                                                       |
| 0    | <b>HiAddrMode: High Addressing Mode.</b> Read-write. 1=If (Ddr3Mode) ODT[3] and CS_L[7:6] are address bits with address timing. |

**D18F2x9C\_x0000\_000E\_dct[3:0] Global Control Slave**

Cold reset: 0000\_0001h.

| Bits | Description                                                                                                                                                                   |
|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:1 | Reserved.                                                                                                                                                                     |
| 0    | <b>G5_Mode: GDDR5 Mode.</b> Read-write. 1=Combo phy slave chip is in GDDR5 mode. 0=Combo phy slave chip is in DDR3 mode. See section <a href="#">2.9</a> for product support. |

**D18F2x9C\_x0[3,1:0][F,3:0]0\_0014\_dct[3:0] Dll Lock Maintenance**

Cold reset: 0000\_0000h. See [2.9.4.1](#) for chiplet to pad mapping.

Table 143: [Index Mapping](#) for [D18F2x9C\\_x0\[3,1:0\]\[F,3:0\]0\\_0014\\_dct\[3:0\]](#)

| Address Bits                             | Valid Values | Name                |
|------------------------------------------|--------------|---------------------|
| <a href="#">D18F2x98_dct[3:0][23:20]</a> | [3:0]        | CAD chiplet         |
| <a href="#">D18F2x98_dct[3:0][23:20]</a> | Fh           | CAD chiplet [3:0]   |
| <a href="#">D18F2x98_dct[3:0][25:24]</a> | [1:0]        | Memory Pstate       |
| <a href="#">D18F2x98_dct[3:0][25:24]</a> | 3h           | Memory Pstate [1:0] |

| Bits | Description |
|------|-------------|
| 31:8 | Reserved.   |

|     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|-----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 7:4 | <b>DllPumpPeriod: Dll charge pump period.</b> Read-write. BIOS: 3h. Specifies the number of DLL relocks required to keep the receive DLLs locked for the period where there is no traffic.                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 3:0 | <b>MaxDurDllNoLock: Max duration Dll no-lock.</b> Read-write. BIOS: See 2.9.9.9. Specifies the number of PCLK cycles that occur before the phy DLLs relock. A DLL relock occurs every $2^{(\text{MaxDurDllNoLock}+1)}$ if there are no reads or writes during the period. 0=DLL power saving(standby) disabled. If $\text{MaxDurDllNoLock} \neq 0$ (standby is enabled), <a href="#">D18F2x9C_x00[F,3:0]0_0078_dct[3:0][DllResetRelock]</a> must be set to 1 prior to writing this register and then <a href="#">D18F2x9C_x00[F,3:0]0_0078_dct[3:0][DllResetRelock]</a> must be cleared after the register write. |

### **D18F2x9C\_x00F0\_0015\_dct[3:0] Vref Byte**

Cold reset: 0000\_0000h.

| Bits | Description                                                                                                                           |
|------|---------------------------------------------------------------------------------------------------------------------------------------|
| 31:4 | Reserved.                                                                                                                             |
| 3:0  | <b>VrefFilt: Vref filter.</b> Read-write. BIOS: 0h. This field adjusts noise coupling on to VrefOut and adjusts the input resistance. |

### **D18F2x9C\_x0[3,1:0][F,3:0]0\_[F,3:0]028\_dct[3:0] CAD RdPtrOffset**

Cold reset: 0000\_0000h. See 2.9.4.1 for chiplet and group (TG) to pin mapping.

Table 144: [Index Mapping](#) for [D18F2x9C\\_x0\[3,1:0\]\[F,3:0\]0\\_\[F,3:0\]028\\_dct\[3:0\]](#)

| Address Bits                             | Valid Values | Name                |
|------------------------------------------|--------------|---------------------|
| <a href="#">D18F2x98_dct[3:0][15:12]</a> | [3:0]        | Timing Group        |
| <a href="#">D18F2x98_dct[3:0][15:12]</a> | Fh           | Timing Group [3:0]  |
| <a href="#">D18F2x98_dct[3:0][23:20]</a> | [3:0]        | CAD chiplet         |
| <a href="#">D18F2x98_dct[3:0][23:20]</a> | Fh           | CAD chiplet [3:0]   |
| <a href="#">D18F2x98_dct[3:0][25:24]</a> | [1:0]        | Memory Pstate       |
| <a href="#">D18F2x98_dct[3:0][25:24]</a> | 3h           | Memory Pstate [1:0] |

| Bits | Description                                                                                                                                                                                                      |
|------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:6 | Reserved.                                                                                                                                                                                                        |
| 5:0  | <b>TxRdPtrOffset: Tx Read Pointer Offset.</b> Read-write. BIOS: See 2.9.9.2.6. The amount of time (specified in units of 2UI) that is added to the read pointer of the Tx command-FIFO for reading out commands. |

### **D18F2x9C\_x00[F,3:0]0\_[F,3:0][8,3:0]2E\_dct[3:0] RdPtrInitVal**

Cold reset: 0000\_0000h. See 2.9.4.1 for chiplet and group (TG) to pin mapping.

Table 145: [Index Mapping](#) for [D18F2x9C\\_x00\[F,3:0\]0\\_\[F,3:0\]\[8,3:0\]2E\\_dct\[3:0\]](#)

| Address Bits                             | Valid Values | Name         |
|------------------------------------------|--------------|--------------|
| <a href="#">D18F2x98_dct[3:0][11:8]</a>  | [3:0]        | NbPstate     |
| <a href="#">D18F2x98_dct[3:0][11:8]</a>  | 8h           | NbPstate PMU |
| <a href="#">D18F2x98_dct[3:0][15:12]</a> | [3:0]        | Timing Group |



Table 145: Index Mapping for D18F2x9C\_x00[F,3:0]0\_[F,3:0][8,3:0]2E\_dct[3:0]

|                          |       |                    |
|--------------------------|-------|--------------------|
| D18F2x98_dct[3:0][15:12] | Fh    | Timing Group [3:0] |
| D18F2x98_dct[3:0][23:20] | [3:0] | CAD chiplet        |
| D18F2x98_dct[3:0][23:20] | Fh    | CAD chiplet [3:0]  |

| Bits | Description                                                                                                                                     |
|------|-------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:6 | Reserved.                                                                                                                                       |
| 5:0  | <b>RdPtrInitVal: Read Pointer Initial Value.</b> Read-write. BIOS: See 2.9.9.2.6. Specifies RdPtr initial value for the transmit command-FIFOs. |

**D18F2x9C\_x0[3,1:0][F,3:0]0\_[F,B:0]041\_dct[3:0] CAD Tx Impedance**

Cold reset: 0000\_0FFFh. BIOS: See 2.9.9.2.4. See 2.9.4.1 for chiplet to pad and 2.9.4 for pad to pin mapping.

Table 146: Address Mapping for D18F2x9C\_x0[3,1:0][F,3:0]0\_[F,B:0]041\_dct[3:0]

| Address                  | Description                                                                                                                                                                                                                                                            |                                    |      |             |           |       |                        |    |           |                                    |
|--------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------|------|-------------|-----------|-------|------------------------|----|-----------|------------------------------------|
| PciCfgDevFunc[11:0]      | 182h                                                                                                                                                                                                                                                                   |                                    |      |             |           |       |                        |    |           |                                    |
| PciCfgOffset[11:0]       | 09Ch                                                                                                                                                                                                                                                                   |                                    |      |             |           |       |                        |    |           |                                    |
| D18F2x98_dct[3:0][31:28] | 0h                                                                                                                                                                                                                                                                     |                                    |      |             |           |       |                        |    |           |                                    |
| D18F2x98_dct[3:0][27:24] | <b>mp: memory P-state selector.</b> <table><tr><th>Value</th><th>Name</th><th>Description</th></tr><tr><td>1h-0h</td><td>1h-0h</td><td>Memory P-state &lt;Value&gt;</td></tr><tr><td>3h</td><td>Broadcast</td><td>Broadcast to Memory P-states [1:0]</td></tr></table> | Value                              | Name | Description | 1h-0h     | 1h-0h | Memory P-state <Value> | 3h | Broadcast | Broadcast to Memory P-states [1:0] |
| Value                    | Name                                                                                                                                                                                                                                                                   | Description                        |      |             |           |       |                        |    |           |                                    |
| 1h-0h                    | 1h-0h                                                                                                                                                                                                                                                                  | Memory P-state <Value>             |      |             |           |       |                        |    |           |                                    |
| 3h                       | Broadcast                                                                                                                                                                                                                                                              | Broadcast to Memory P-states [1:0] |      |             |           |       |                        |    |           |                                    |
| D18F2x98_dct[3:0][23:20] | <b>chiplet: chiplet selector.</b> <table><tr><th>Value</th><th>Name</th><th>Description</th></tr><tr><td>3h-0h</td><td>3-0</td><td>Chiplet &lt;Value&gt;</td></tr><tr><td>Fh</td><td>Broadcast</td><td>Broadcast to chiplets [8:0]</td></tr></table>                   | Value                              | Name | Description | 3h-0h     | 3-0   | Chiplet <Value>        | Fh | Broadcast | Broadcast to chiplets [8:0]        |
| Value                    | Name                                                                                                                                                                                                                                                                   | Description                        |      |             |           |       |                        |    |           |                                    |
| 3h-0h                    | 3-0                                                                                                                                                                                                                                                                    | Chiplet <Value>                    |      |             |           |       |                        |    |           |                                    |
| Fh                       | Broadcast                                                                                                                                                                                                                                                              | Broadcast to chiplets [8:0]        |      |             |           |       |                        |    |           |                                    |
| D18F2x98_dct[3:0][19:16] | 0h                                                                                                                                                                                                                                                                     |                                    |      |             |           |       |                        |    |           |                                    |
| D18F2x98_dct[3:0][15:12] | <b>pad: pad selector.</b> <table><tr><th>Value</th><th>Name</th><th>Description</th></tr><tr><td>Bh-0h</td><td>Bh-0h</td><td>pad &lt;Value&gt;</td></tr><tr><td>Fh</td><td>Broadcast</td><td>Broadcast to pad pads [B:0]</td></tr></table>                             | Value                              | Name | Description | Bh-0h     | Bh-0h | pad <Value>            | Fh | Broadcast | Broadcast to pad pads [B:0]        |
| Value                    | Name                                                                                                                                                                                                                                                                   | Description                        |      |             |           |       |                        |    |           |                                    |
| Bh-0h                    | Bh-0h                                                                                                                                                                                                                                                                  | pad <Value>                        |      |             |           |       |                        |    |           |                                    |
| Fh                       | Broadcast                                                                                                                                                                                                                                                              | Broadcast to pad pads [B:0]        |      |             |           |       |                        |    |           |                                    |
| D18F2x98_dct[3:0][11:0]  | 041h                                                                                                                                                                                                                                                                   |                                    |      |             |           |       |                        |    |           |                                    |
| D18F1x10C[DctCfgSel]     | <b>dct: DCT controller select.</b> <table><tr><th>Value</th><th>Name</th><th>Description</th></tr><tr><td>011b-000b</td><td>3h-0h</td><td>DCT &lt;Value&gt;</td></tr></table>                                                                                          | Value                              | Name | Description | 011b-000b | 3h-0h | DCT <Value>            |    |           |                                    |
| Value                    | Name                                                                                                                                                                                                                                                                   | Description                        |      |             |           |       |                        |    |           |                                    |
| 011b-000b                | 3h-0h                                                                                                                                                                                                                                                                  | DCT <Value>                        |      |             |           |       |                        |    |           |                                    |

| Bits  | Description |
|-------|-------------|
| 31:12 | Reserved.   |

| 11:6 | <b>DrvStrenP: PMOS driver output impedance.</b> Read-write. BIOS: See 2.9.9.2.4. Specifies the pull-down output driver impedance. See DrvStrenN for field description.                                                                                                                                                                                                                                                                                                             |      |             |     |          |     |          |     |         |     |         |     |         |     |         |     |         |
|------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|-----|----------|-----|----------|-----|---------|-----|---------|-----|---------|-----|---------|-----|---------|
| 5:0  | <b>DrvStrenN: NMOS driver output impedance.</b> Read-write. BIOS: See 2.9.9.2.4. Specifies the pull-up output driver impedance.<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00h</td><td>disabled</td></tr> <tr> <td>01h</td><td>120 ohms</td></tr> <tr> <td>03h</td><td>60 ohms</td></tr> <tr> <td>07h</td><td>40 ohms</td></tr> <tr> <td>0Fh</td><td>30 ohms</td></tr> <tr> <td>1Fh</td><td>24 ohms</td></tr> <tr> <td>3Fh</td><td>20 ohms</td></tr> </table> | Bits | Description | 00h | disabled | 01h | 120 ohms | 03h | 60 ohms | 07h | 40 ohms | 0Fh | 30 ohms | 1Fh | 24 ohms | 3Fh | 20 ohms |
| Bits | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |      |             |     |          |     |          |     |         |     |         |     |         |     |         |     |         |
| 00h  | disabled                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |      |             |     |          |     |          |     |         |     |         |     |         |     |         |     |         |
| 01h  | 120 ohms                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |      |             |     |          |     |          |     |         |     |         |     |         |     |         |     |         |
| 03h  | 60 ohms                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |      |             |     |          |     |          |     |         |     |         |     |         |     |         |     |         |
| 07h  | 40 ohms                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |      |             |     |          |     |          |     |         |     |         |     |         |     |         |     |         |
| 0Fh  | 30 ohms                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |      |             |     |          |     |          |     |         |     |         |     |         |     |         |     |         |
| 1Fh  | 24 ohms                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |      |             |     |          |     |          |     |         |     |         |     |         |     |         |     |         |
| 3Fh  | 20 ohms                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |      |             |     |          |     |          |     |         |     |         |     |         |     |         |     |         |

### D18F2x9C\_x00[F,3:0]0\_[F,B:0]04A\_dct[3:0] Rx Control 1

Cold reset: 0000\_0080h. See 2.9.4.1 for chiplet to pad and 2.9.4 for pad to pin mapping.

Table 147: Index Mapping for D18F2x9C\_x00[F,3:0]0\_[F,B:0]04A\_dct[3:0]

| Address Bits             | Valid Values | Name              |
|--------------------------|--------------|-------------------|
| D18F2x98_dct[3:0][15:12] | [B:0]        | pad               |
| D18F2x98_dct[3:0][15:12] | Fh           | pad[B:0]          |
| D18F2x98_dct[3:0][23:20] | [3:0]        | CAD chiplet       |
| D18F2x98_dct[3:0][23:20] | Fh           | CAD chiplet [3:0] |

| Bits      | Description                                                                                                                                                                                                                                                |      |             |      |      |           |          |
|-----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|------|------|-----------|----------|
| 31:9      | Reserved.                                                                                                                                                                                                                                                  |      |             |      |      |           |          |
| 8         | <b>BiasBypassEn: Bias bypass enable.</b> Read-write. BIOS: 0.                                                                                                                                                                                              |      |             |      |      |           |          |
| 7         | <b>PowerDownRcvr: Power down receiver.</b> Read-write. BIOS: See 2.9.9.9. 1=Power down the receiver.                                                                                                                                                       |      |             |      |      |           |          |
| 6:4       | <b>MajorMode: Major mode.</b> Read-write. BIOS: See 2.9.9.2. Specifies operating mode of the phy logic.<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>000b</td><td>DDR3</td></tr> <tr> <td>111b-001b</td><td>Reserved</td></tr> </table> | Bits | Description | 000b | DDR3 | 111b-001b | Reserved |
| Bits      | Description                                                                                                                                                                                                                                                |      |             |      |      |           |          |
| 000b      | DDR3                                                                                                                                                                                                                                                       |      |             |      |      |           |          |
| 111b-001b | Reserved                                                                                                                                                                                                                                                   |      |             |      |      |           |          |
| 3:0       | Reserved.                                                                                                                                                                                                                                                  |      |             |      |      |           |          |

### D18F2x9C\_x00[F,3:0]0\_[F,B:0]04E\_dct[3:0] TxControlDq

Cold reset: 0000\_0013h. See 2.9.4.1 for chiplet to pad and 2.9.4 for pad to pin mapping.

Table 148: Index Mapping for D18F2x9C\_x00[F,3:0]0\_[F,B:0]04E\_dct[3:0]

| Address Bits             | Valid Values | Name              |
|--------------------------|--------------|-------------------|
| D18F2x98_dct[3:0][15:12] | [B:0]        | pad               |
| D18F2x98_dct[3:0][15:12] | Fh           | pad[B:0]          |
| D18F2x98_dct[3:0][23:20] | [3:0]        | CAD chiplet       |
| D18F2x98_dct[3:0][23:20] | Fh           | CAD chiplet [3:0] |

| Bits  | Description                                                        |
|-------|--------------------------------------------------------------------|
| 31:13 | Reserved.                                                          |
| 12    | <b>EQEnable: Equalization enable.</b> Read-write. BIOS: 0.         |
| 11    | <b>DrvPwrGateEn: Powergate driver enable.</b> Read-write. BIOS: 1. |
| 10:0  | Reserved.                                                          |

#### D18F2x9C\_x00[F,3:0]0\_[F,B:0]05F\_dct[3:0] CAD Tx Slew Rate

Cold reset: 0000\_03FFh. BIOS: See 2.9.9.2.4. See 2.9.4.1 for chiplet to pad mapping and 2.9.4 for pad to pin mapping.

Table 149: Index Mapping for D18F2x9C\_x00[F,3:0]0\_[F,B:0]05F\_dct[3:0]

| Address Bits             | Valid Values | Name              |
|--------------------------|--------------|-------------------|
| D18F2x98_dct[3:0][15:12] | [B:0]        | pad               |
| D18F2x98_dct[3:0][15:12] | Fh           | pad[B:0]          |
| D18F2x98_dct[3:0][23:20] | [3:0]        | CAD chiplet       |
| D18F2x98_dct[3:0][23:20] | Fh           | CAD chiplet [3:0] |

| Bits | Description                                                                                                                                                                    |
|------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:6 | Reserved.                                                                                                                                                                      |
| 5:3  | <b>TxPreN: NMOS predriver code.</b> Read-write. BIOS: See 2.9.9.2.7. Specifies the falling edge slew rate of the transmit pad. 000b=Slowest slew rate. 111b=Fastest slew rate. |
| 2:0  | <b>TxPreP: PMOS predriver code.</b> Read-write. BIOS: See 2.9.9.2.7. Specifies the rising edge slew rate of the transmit pad. 000b=Slowest slew rate. 111b=Fastest slew rate.  |

#### D18F2x9C\_x00[F,3:0]0\_0077\_dct[3:0] DllPowerdown

Cold reset: 0000\_0000h. BIOS: See 2.9.9.9. See 2.9.4.1 for chiplet to pad mapping and see 2.9.4 for pad to pin mapping.

Table 150: Address Mapping for D18F2x9C\_x00[F,3:0]0\_0077\_dct[3:0]

| Address                  | Description                                                                                                                                                                                                                                          |                             |      |             |           |       |                 |    |           |                             |
|--------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|------|-------------|-----------|-------|-----------------|----|-----------|-----------------------------|
| PciCfgDevFunc[11:0]      | 182h                                                                                                                                                                                                                                                 |                             |      |             |           |       |                 |    |           |                             |
| PciCfgOffset[11:0]       | 09Ch                                                                                                                                                                                                                                                 |                             |      |             |           |       |                 |    |           |                             |
| D18F2x98_dct[3:0][31:24] | 00h                                                                                                                                                                                                                                                  |                             |      |             |           |       |                 |    |           |                             |
| D18F2x98_dct[3:0][23:20] | <b>chiplet: chiplet selector.</b> <table><tr><th>Value</th><th>Name</th><th>Description</th></tr><tr><td>3h-0h</td><td>3-0</td><td>Chiplet &lt;Value&gt;</td></tr><tr><td>Fh</td><td>Broadcast</td><td>Broadcast to chiplets [3:0]</td></tr></table> | Value                       | Name | Description | 3h-0h     | 3-0   | Chiplet <Value> | Fh | Broadcast | Broadcast to chiplets [3:0] |
| Value                    | Name                                                                                                                                                                                                                                                 | Description                 |      |             |           |       |                 |    |           |                             |
| 3h-0h                    | 3-0                                                                                                                                                                                                                                                  | Chiplet <Value>             |      |             |           |       |                 |    |           |                             |
| Fh                       | Broadcast                                                                                                                                                                                                                                            | Broadcast to chiplets [3:0] |      |             |           |       |                 |    |           |                             |
| D18F2x98_dct[3:0][19:12] | 10h                                                                                                                                                                                                                                                  |                             |      |             |           |       |                 |    |           |                             |
| D18F2x98_dct[3:0][19:0]  | 00077h                                                                                                                                                                                                                                               |                             |      |             |           |       |                 |    |           |                             |
| D18F1x10C[DctCfgSel]     | <b>dct: DCT controller select.</b> <table><tr><th>Value</th><th>Name</th><th>Description</th></tr><tr><td>011b-000b</td><td>3h-0h</td><td>DCT &lt;Value&gt;</td></tr></table>                                                                        | Value                       | Name | Description | 011b-000b | 3h-0h | DCT <Value>     |    |           |                             |
| Value                    | Name                                                                                                                                                                                                                                                 | Description                 |      |             |           |       |                 |    |           |                             |
| 011b-000b                | 3h-0h                                                                                                                                                                                                                                                | DCT <Value>                 |      |             |           |       |                 |    |           |                             |

| Bits  | Description                                              |
|-------|----------------------------------------------------------|
| 31:11 | Reserved.                                                |
| 10:6  | <b>DllPowerDownTx: Dll powerdown Tx.</b> Read-write.     |
| 5     | <b>DllPowerDownXCLK: Dll powerdown XCLK.</b> Read-write. |
| 4     | Reserved.                                                |
| 3:1   | <b>DllPowerDownPI: Dll powerdown PI.</b> Read-write.     |
| 0     | <b>DllPowerDown: Dll powerdown.</b> Read-write.          |

### **D18F2x9C\_x00[F,3:0]0\_0078\_dct[3:0] DllControl**

Cold reset: 0000\_0000h. See 2.9.4.1 for chiplet to pad mapping and see 2.9.4 for pad to pin mapping.

Table 151: Address Mapping for D18F2x9C\_x00[F,3:0]0\_0078\_dct[3:0]

| Address                  | Description                                                                                                                                                                                                                                          |                             |      |             |           |       |                 |    |           |                             |
|--------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|------|-------------|-----------|-------|-----------------|----|-----------|-----------------------------|
| PciCfgDevFunc[11:0]      | 182h                                                                                                                                                                                                                                                 |                             |      |             |           |       |                 |    |           |                             |
| PciCfgOffset[11:0]       | 09Ch                                                                                                                                                                                                                                                 |                             |      |             |           |       |                 |    |           |                             |
| D18F2x98_dct[3:0][31:24] | 00h                                                                                                                                                                                                                                                  |                             |      |             |           |       |                 |    |           |                             |
| D18F2x98_dct[3:0][23:20] | <b>chiplet: chiplet selector.</b> <table><tr><th>Value</th><th>Name</th><th>Description</th></tr><tr><td>3h-0h</td><td>3-0</td><td>Chiplet &lt;Value&gt;</td></tr><tr><td>Fh</td><td>Broadcast</td><td>Broadcast to chiplets [3:0]</td></tr></table> | Value                       | Name | Description | 3h-0h     | 3-0   | Chiplet <Value> | Fh | Broadcast | Broadcast to chiplets [3:0] |
| Value                    | Name                                                                                                                                                                                                                                                 | Description                 |      |             |           |       |                 |    |           |                             |
| 3h-0h                    | 3-0                                                                                                                                                                                                                                                  | Chiplet <Value>             |      |             |           |       |                 |    |           |                             |
| Fh                       | Broadcast                                                                                                                                                                                                                                            | Broadcast to chiplets [3:0] |      |             |           |       |                 |    |           |                             |
| D18F2x98_dct[3:0][19:12] | 10h                                                                                                                                                                                                                                                  |                             |      |             |           |       |                 |    |           |                             |
| D18F2x98_dct[3:0][19:0]  | 00078h                                                                                                                                                                                                                                               |                             |      |             |           |       |                 |    |           |                             |
| D18F1x10C[DctCfgSel]     | <b>dct: DCT controller select.</b> <table><tr><th>Value</th><th>Name</th><th>Description</th></tr><tr><td>011b-000b</td><td>3h-0h</td><td>DCT &lt;Value&gt;</td></tr></table>                                                                        | Value                       | Name | Description | 011b-000b | 3h-0h | DCT <Value>     |    |           |                             |
| Value                    | Name                                                                                                                                                                                                                                                 | Description                 |      |             |           |       |                 |    |           |                             |
| 011b-000b                | 3h-0h                                                                                                                                                                                                                                                | DCT <Value>                 |      |             |           |       |                 |    |           |                             |

| Bits | Description                                                                                                                                                                             |
|------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:8 | Reserved.                                                                                                                                                                               |
| 7    | <b>DllResetRelock: Dll reset relock.</b> Read-write. 1=Reset the DLL. 0=Relock the DLL. This bit must be set for 20 ns and then cleared anytime a forced relock of the DLL is required. |
| 6:0  | Reserved.                                                                                                                                                                               |

### **D18F2x9C\_x0[3,1:0][F,3:0]0\_[F,3:0]081\_dct[3:0] Tx Delay**

Cold reset: 0000\_0000h. BIOS: See 2.9.9.2.10. This register controls the timing of the address, command, chip select, ODT and clock enable pins with respect to memory clock. See 2.9.4.1 for chiplet/timing group to pad and 2.9.4 for pad to pin mapping.

Table 152: Index Mapping for D18F2x9C\_x0[3,1:0][F,3:0]0\_[F,3:0]081\_dct[3:0]

| Address Bits             | Valid Values | Name               |
|--------------------------|--------------|--------------------|
| D18F2x98_dct[3:0][15:12] | [3:0]        | Timing Group       |
| D18F2x98_dct[3:0][15:12] | Fh           | Timing Group [3:0] |

Table 152: Index Mapping for D18F2x9C\_x0[3,1:0][F,3:0]0\_[F,3:0]081\_dct[3:0]

|                          |       |                     |
|--------------------------|-------|---------------------|
| D18F2x98_dct[3:0][23:20] | [3:0] | CAD chiplet         |
| D18F2x98_dct[3:0][23:20] | Fh    | CAD chiplet [3:0]   |
| D18F2x98_dct[3:0][25:24] | [1:0] | Memory Pstate       |
| D18F2x98_dct[3:0][25:24] | 3h    | Memory Pstate [1:0] |

| Bits | Description                                                                                                                                                         |
|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:5 | Reserved.                                                                                                                                                           |
| 4:0  | <b>TxFineDly: Tx fine delay.</b> Read-write. Specifies the time that the address/command signals are delayed from the default setup time, in increments of 1/32 UI. |

**D18F2x9C\_x00[F,8:0]1\_0000\_dct[3:0] VariousChicken**

Cold reset: 0000\_0000h. BIOS: See 2.9.9.9.

Table 153: Index Mapping for D18F2x9C\_x00[F,8:0]1\_0000\_dct[3:0]

| Address Bits             | Valid Values | Name               |
|--------------------------|--------------|--------------------|
| D18F2x98_dct[3:0][23:20] | [8:0]        | Data chiplet       |
| D18F2x98_dct[3:0][23:20] | Fh           | Data chiplet [8:0] |

| Bits | Description                                                                                                                                                                                                    |
|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:3 | Reserved.                                                                                                                                                                                                      |
| 2    | <b>DByteEnable: data byte enable.</b> Read-write. Controls whether this DBYTE is enabled. If this DBYTE is not enabled, it receives no clocks and remains in reset. 1=Disable this DBYTE. 0=Enable this DBYTE. |
| 1:0  | Reserved.                                                                                                                                                                                                      |

**D18F2x9C\_x0001\_000E\_dct[3:0] Global Control Slave**

Cold reset: 0000\_0001h.

| Bits | Description                                                                                                                                                   |
|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:1 | Reserved.                                                                                                                                                     |
| 0    | <b>G5_Mode: GDDR5 Mode.</b> Read-write. 1=Combo phy slave chip is in GDDR5 mode. 0=Combo phy slave chip is in DDR3 mode. See section 2.9 for product support. |

**D18F2x9C\_x0[3,1:0][F,8:0]1\_0014\_dct[3:0] Dll Lock Maintenance**

Cold reset: 0000\_0037h. See 2.9.4.1 for chiplet to pin mapping.

Table 154: Index Mapping for D18F2x9C\_x0[3,1:0][F,8:0]1\_0014\_dct[3:0]

| Address Bits | Valid Values | Name |
|--------------|--------------|------|
|--------------|--------------|------|

Table 154: Index Mapping for D18F2x9C\_x0[3,1:0][F,8:0]1\_0014\_dct[3:0]

|                          |       |                     |
|--------------------------|-------|---------------------|
| D18F2x98_dct[3:0][23:20] | [8:0] | Data chiplet        |
| D18F2x98_dct[3:0][23:20] | Fh    | Data chiplet [8:0]  |
| D18F2x98_dct[3:0][27:24] | [1:0] | Memory Pstate       |
| D18F2x98_dct[3:0][27:24] | 3h    | Memory Pstate [1:0] |

| Bits | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:8 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 7:4  | <b>DllPumpPeriod: Dll charge pump period.</b> Read-write. BIOS: 3h. Specifies the number of DLL relocks required to keep the receive DLLs locked for the period where there is no traffic.                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 3:0  | <b>MaxDurDllNoLock: Max duration Dll no-lock.</b> Read-write. BIOS: See 2.9.9.9. Specifies the number of PCLK cycles that occur before the phy DLLs relock. A DLL relock occurs every $2^{(\text{MaxDurDllNoLock}+1)}$ if there are no reads or writes during the period. 0=DLL power saving(standby) disabled. If MaxDurDllNoLock!=0 (standby is enabled), <a href="#">D18F2x9C_x00[F,8:0]1_0[F,2:0]78_dct[3:0][DllResetRelock]</a> must be set to 1 prior to writing this register and then <a href="#">D18F2x9C_x00[F,8:0]1_0[F,2:0]78_dct[3:0][DllResetRelock]</a> must be cleared after the register write. |

**D18F2x9C\_x00F1\_0015\_dct[3:0] Vref Byte**

Cold reset: 0000\_0000h.

| Bits | Description                                                                                                                           |
|------|---------------------------------------------------------------------------------------------------------------------------------------|
| 31:4 | Reserved.                                                                                                                             |
| 3:0  | <b>VrefFilt: Vref filter.</b> Read-write. BIOS: 0h. This field adjusts noise coupling on to VrefOut and adjusts the input resistance. |

**D18F2x9C\_x00[F,8:0]1\_0016\_dct[3:0] Proc Odt Timing**

Cold reset: 0000\_1244h. See 2.9.4.1 for chiplet to pin mapping.

Table 155: [Index Mapping](#) for D18F2x9C\_x00[F,8:0]1\_0016\_dct[3:0]

| Address Bits                             | Valid Values | Name               |
|------------------------------------------|--------------|--------------------|
| <a href="#">D18F2x98_dct[3:0][23:20]</a> | [8:0]        | Data chiplet       |
| <a href="#">D18F2x98_dct[3:0][23:20]</a> | Fh           | Data chiplet [8:0] |

| Bits        | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                     |             |              |           |                          |           |          |     |                                                                                                         |
|-------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|--------------|-----------|--------------------------|-----------|----------|-----|---------------------------------------------------------------------------------------------------------|
| 31:16       | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                       |             |              |           |                          |           |          |     |                                                                                                         |
| 15          | <b>ProcOdtOn: Proc ODT on.</b> Read-write. BIOS: IF ( <a href="#">Gddr5Mode</a> ) THEN 1 ELSE 0. 1=Controller always enables ODT when not driving. If <a href="#">Gddr5Mode</a> this may be used as G5ParkOdt.                                                                                                                                                                                                                                                  |             |              |           |                          |           |          |     |                                                                                                         |
| 14          | <b>ProcOdtOff: Proc ODT off.</b> Read-write. BIOS: 0. 1=Controller never enables ODT unless ProcOdtOn=1.                                                                                                                                                                                                                                                                                                                                                        |             |              |           |                          |           |          |     |                                                                                                         |
| 13:11       | <b>POdtStartDelayDqs: Proc ODT start delay DQS.</b> Read-write. BIOS: 2h. Controls the ODT turn on delay for DQS during reads.<br><table> <tr> <td><u>Bits</u></td><td><u>Delay</u></td></tr> <tr> <td>100b-000b</td><td>&lt;2*POdtStartDelayDqs&gt; UI</td></tr> <tr> <td>110b-101b</td><td>Reserved</td></tr> <tr> <td>111</td><td>Uses RxTraffic to turn-on at the earliest possible time and stays enabled for duration of DLL operation</td></tr> </table> | <u>Bits</u> | <u>Delay</u> | 100b-000b | <2*POdtStartDelayDqs> UI | 110b-101b | Reserved | 111 | Uses RxTraffic to turn-on at the earliest possible time and stays enabled for duration of DLL operation |
| <u>Bits</u> | <u>Delay</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                    |             |              |           |                          |           |          |     |                                                                                                         |
| 100b-000b   | <2*POdtStartDelayDqs> UI                                                                                                                                                                                                                                                                                                                                                                                                                                        |             |              |           |                          |           |          |     |                                                                                                         |
| 110b-101b   | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                        |             |              |           |                          |           |          |     |                                                                                                         |
| 111         | Uses RxTraffic to turn-on at the earliest possible time and stays enabled for duration of DLL operation                                                                                                                                                                                                                                                                                                                                                         |             |              |           |                          |           |          |     |                                                                                                         |
| 10:8        | <b>POdtStartDelayDq: Proc ODT start delay DQ.</b> Read-write. BIOS: 2h. Controls the ODT turn on delay for DQ during reads.<br><table> <tr> <td><u>Bits</u></td><td><u>Delay</u></td></tr> <tr> <td>100b-000b</td><td>&lt;2*POdtStartDelayDq&gt; UI</td></tr> <tr> <td>110b-101b</td><td>Reserved</td></tr> <tr> <td>111</td><td>Uses RxTraffic to turn-on at the earliest possible time and stays enabled for duration of DLL operation</td></tr> </table>     | <u>Bits</u> | <u>Delay</u> | 100b-000b | <2*POdtStartDelayDq> UI  | 110b-101b | Reserved | 111 | Uses RxTraffic to turn-on at the earliest possible time and stays enabled for duration of DLL operation |
| <u>Bits</u> | <u>Delay</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                    |             |              |           |                          |           |          |     |                                                                                                         |
| 100b-000b   | <2*POdtStartDelayDq> UI                                                                                                                                                                                                                                                                                                                                                                                                                                         |             |              |           |                          |           |          |     |                                                                                                         |
| 110b-101b   | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                        |             |              |           |                          |           |          |     |                                                                                                         |
| 111         | Uses RxTraffic to turn-on at the earliest possible time and stays enabled for duration of DLL operation                                                                                                                                                                                                                                                                                                                                                         |             |              |           |                          |           |          |     |                                                                                                         |

|     |                                                                                                                                                                                                                                                                                                             |
|-----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 7:4 | <b>POdtWidthDqs: Proc ODT width DQS.</b> Read-write. BIOS: 4h. Controls the duration of ODT for DQS during reads.<br><div> <div>Bits</div> <div>Duration</div> </div> <div> <div>0100b-0000b</div> <div>&lt;10+(2*POdtWidthDqs)&gt; UI</div> </div> <div> <div>1111b-0101b</div> <div>Reserved</div> </div> |
| 3:0 | <b>POdtWidthDq: Proc ODT width DQ.</b> Read-write. BIOS: 4h. Controls the duration of ODT for DQ during reads.<br><div> <div>Bits</div> <div>Duration</div> </div> <div> <div>0100b-0000b</div> <div>&lt;8+(2*POdtWidthDq)&gt; UI</div> </div> <div> <div>1111b-0101b</div> <div>Reserved</div> </div>      |

### D18F2x9C\_x00[F,8:0]1\_001C\_dct[3:0] Dynamic PowerDown

Cold reset: 0000\_0001h. BIOS: See 2.9.9.9. See 2.9.4.1 for chiplet to pin mapping.

Table 156: Index Mapping for D18F2x9C\_x00[F,8:0]1\_001C\_dct[3:0]

| Address Bits             | Valid Values | Name               |
|--------------------------|--------------|--------------------|
| D18F2x98_dct[3:0][23:20] | [8:0]        | Data chiplet       |
| D18F2x98_dct[3:0][23:20] | Fh           | Data chiplet [8:0] |

| Bits | Description                                                                            |
|------|----------------------------------------------------------------------------------------|
| 31:1 | Reserved.                                                                              |
| 0    | <b>DynPowerDown: Dynamic Power Down.</b> Read-write. 1=analog circuitry is turned off. |

### D18F2x9C\_x0[3,1:0][F,8:0]1\_0028\_dct[3:0] DATA RdPtrOffset

Cold reset: 0000\_018Ah. See 2.9.4.1 for chiplet to pin mapping.

Table 157: Index Mapping for D18F2x9C\_x0[3,1:0][F,8:0]1\_0028\_dct[3:0]

| Address Bits             | Valid Values | Name                |
|--------------------------|--------------|---------------------|
| D18F2x98_dct[3:0][23:20] | [8:0]        | Data chiplet        |
| D18F2x98_dct[3:0][23:20] | Fh           | Data chiplet [8:0]  |
| D18F2x98_dct[3:0][25:24] | [1:0]        | Memory Pstate       |
| D18F2x98_dct[3:0][25:24] | 3h           | Memory Pstate [1:0] |

| Bits  | Description                                                                                                                                                                                                                        |
|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:11 | Reserved.                                                                                                                                                                                                                          |
| 10:6  | <b>TxDPtrOffset: Tx Read Pointer Offset.</b> Read-write. BIOS: See 2.9.9.2.6. The amount of time (specified in units of 2UI) that is added to the read pointer of the Tx FIFO for reading out Tx data from the Tx data-FIFO.       |
| 5:0   | <b>RxDPtrOffset: Rx Read Pointer Offset.</b> Read-write. BIOS: See 2.9.9.2.6. The amount of time (specified in units of 2UI) that is added to the read pointer of the Rx FIFO for reading out received data from the Rx data-FIFO. |



**D18F2x9C\_x0[3,1:0][F,8:0]1\_0029\_dct[3:0] Dll Early Traffic Offset**

Cold reset: 0000\_0000h. BIOS: See 2.9.9.9. See 2.9.4.1 for chiplet to pin mapping.

Table 158: Index Mapping for D18F2x9C\_x0[3,1:0][F,8:0]1\_0029\_dct[3:0]

| Address Bits             | Valid Values | Name                |
|--------------------------|--------------|---------------------|
| D18F2x98_dct[3:0][23:20] | [8:0]        | Data chiplet        |
| D18F2x98_dct[3:0][23:20] | Fh           | Data chiplet [8:0]  |
| D18F2x98_dct[3:0][27:24] | [1:0]        | Memory Pstate       |
| D18F2x98_dct[3:0][27:24] | 3h           | Memory Pstate [1:0] |

| Bits  | Description                                                                                                                                            |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:11 | Reserved.                                                                                                                                              |
| 10:6  | <b>TxTrafficOffset: Rx stagger postamble.</b> Read-write. Specifies the amount of time that TxEarlyTraffic will be asserted prior to TxEn , unit=2*UI. |
| 5:0   | <b>RxTrafficOffset: Rx stagger preamble.</b> Read-write. Specifies the amount of time that RxEarlyTraffic will be asserted prior to RxEn , unit=2*UI.  |

**D18F2x9C\_x0[3,1:0][F,8:0]1\_002A\_dct[3:0] Rx Dll Standby Stagger Config**

Cold reset: 0000\_0000h. BIOS: See 2.9.9.9. See 2.9.4.1 for chiplet to pin mapping.

Table 159: Index Mapping for D18F2x9C\_x0[3,1:0][F,8:0]1\_002A\_dct[3:0]

| Address Bits             | Valid Values | Name                |
|--------------------------|--------------|---------------------|
| D18F2x98_dct[3:0][23:20] | [8:0]        | Data chiplet        |
| D18F2x98_dct[3:0][23:20] | Fh           | Data chiplet [8:0]  |
| D18F2x98_dct[3:0][27:24] | [1:0]        | Memory Pstate       |
| D18F2x98_dct[3:0][27:24] | 3h           | Memory Pstate [1:0] |

| Bits  | Description                                                                                                                              |
|-------|------------------------------------------------------------------------------------------------------------------------------------------|
| 31:12 | Reserved.                                                                                                                                |
| 11:6  | <b>RxStggrPost: Rx stagger postamble.</b> Read-write. Specifies the duration Rx Dlls remain locked after read request (RxEn), unit=4*UI. |
| 5:0   | <b>RxStggrAnte: Rx stagger preamble.</b> Read-write. Specifies the duration Rx Dlls remain locked after RxEarlyTraffic, unit=4*UI.       |

**D18F2x9C\_x0[3,1:0][F,8:0]1\_002B\_dct[3:0] Tx Dll Standby Stagger Config**

Cold reset: 0000\_0000h. BIOS: See 2.9.9.9. See 2.9.4.1 for chiplet to pin mapping.

Table 160: Index Mapping for D18F2x9C\_x0[3,1:0][F,8:0]1\_002B\_dct[3:0]

| Address Bits             | Valid Values | Name                |
|--------------------------|--------------|---------------------|
| D18F2x98_dct[3:0][23:20] | [8:0]        | Data chiplet        |
| D18F2x98_dct[3:0][23:20] | Fh           | Data chiplet [8:0]  |
| D18F2x98_dct[3:0][27:24] | [1:0]        | Memory Pstate       |
| D18F2x98_dct[3:0][27:24] | 3h           | Memory Pstate [1:0] |

| Bits  | Description                                                                                                                               |
|-------|-------------------------------------------------------------------------------------------------------------------------------------------|
| 31:10 | Reserved.                                                                                                                                 |
| 9:5   | <b>TxStggrPost: Tx stagger postamble.</b> Read-write. Specifies the duration Tx Dlls remain locked after write request (TxEn), unit=4*UI. |
| 4:0   | <b>TxStggrAnte: Tx stagger preamble.</b> Read-write. Specifies the duration Tx Dlls remain locked after TxEarlyTraffic, unit=4*UI.        |

**D18F2x9C\_x0[3,1:0][F,8:0]1\_002C\_dct[3:0] Rx Pad Traffic Early Offset**

Cold reset: 0000\_0000h. BIOS: See 2.9.9.9. See 2.9.4.1 for chiplet to pin mapping.

Table 161: Index Mapping for D18F2x9C\_x0[3,1:0][F,8:0]1\_002C\_dct[3:0]

| Address Bits             | Valid Values | Name                |
|--------------------------|--------------|---------------------|
| D18F2x98_dct[3:0][23:20] | [8:0]        | Data chiplet        |
| D18F2x98_dct[3:0][23:20] | Fh           | Data chiplet [8:0]  |
| D18F2x98_dct[3:0][27:24] | [1:0]        | Memory Pstate       |
| D18F2x98_dct[3:0][27:24] | 3h           | Memory Pstate [1:0] |

| Bits | Description                                                                                                                                       |
|------|---------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:6 | Reserved.                                                                                                                                         |
| 5:0  | <b>RxPadTrafficOffset: Rx pad traffic offset.</b> Read-write. Specifies the duration RxPadEarlyTraffic will be asserted prior to RxEn, unit=2*UI. |

**D18F2x9C\_x00[F,8:0]1\_0[8,3:0]2E\_dct[3:0] DATA RdPtrInitVal**

Cold reset: 0000\_0000h. See 2.9.4.1 for chiplet to pin mapping.

Table 162: Index Mapping for D18F2x9C\_x00[F,8:0]1\_0[8,3:0]2E\_dct[3:0]

| Address Bits             | Valid Values | Name               |
|--------------------------|--------------|--------------------|
| D18F2x98_dct[3:0][11:8]  | [3:0]        | NbPstate           |
| D18F2x98_dct[3:0][11:8]  | 8h           | NbPstate PMU       |
| D18F2x98_dct[3:0][23:20] | [8:0]        | Data chiplet       |
| D18F2x98_dct[3:0][23:20] | Fh           | Data chiplet [8:0] |

| Bits | Description                                                                                                                                                                                                                                  |
|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:7 | Reserved.                                                                                                                                                                                                                                    |
| 6:2  | <b>RdPtrInitVal[6:2]: Rd pointer initial value[6:2].</b> Read-write. BIOS: See 2.9.9.2.6. Specifies RdPtr initial value for the transmit FIFOs. Each RdPtrInitVal[6:0] is in units of UI. Software may write entire RdPtrInitVal[6:0] field. |
| 1:0  | <b>RdPtrInitVal[1:0]: Rd pointer initial value[1:0].</b> RAZ. BIOS: See 2.9.9.2.6. Specifies RdPtr initial value for the transmit FIFOs. Each RdPtrInitVal[6:0] is in units of UI. Software may write entire RdPtrInitVal[6:0] field.        |

### **D18F2x9C\_x0[3,1:0][F,8:0]1\_[F,B:0]041\_dct[3:0] DATA Tx Impedance**

Cold reset: 0000\_3FFFh. See 2.9.4.1 for chiplet to pin mapping.

Table 163: Address Mapping for D18F2x9C\_x0[3,1:0][F,8:0]1\_[F,B:0]041\_dct[3:0]

| Address                  | Description                                                                                                                                                                                                                                          |                             |      |             |       |     |                 |    |           |                             |
|--------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|------|-------------|-------|-----|-----------------|----|-----------|-----------------------------|
| PciCfgDevFunc[11:0]      | 182h                                                                                                                                                                                                                                                 |                             |      |             |       |     |                 |    |           |                             |
| PciCfgOffset[11:0]       | 09Ch                                                                                                                                                                                                                                                 |                             |      |             |       |     |                 |    |           |                             |
| D18F2x98_dct[3:0][31:28] | 0h                                                                                                                                                                                                                                                   |                             |      |             |       |     |                 |    |           |                             |
| D18F2x98_dct[3:0][27:24] | <b>mp: memory P-state selector.</b> See: Table 146 [Address Mapping for D18F2x9C_x0[3,1:0][F,3:0]0_[F,B:0]041_dct[3:0]].                                                                                                                             |                             |      |             |       |     |                 |    |           |                             |
| D18F2x98_dct[3:0][23:20] | <b>chiplet: chiplet selector.</b> <table><tr><th>Value</th><th>Name</th><th>Description</th></tr><tr><td>8h-0h</td><td>8-0</td><td>Chiplet &lt;Value&gt;</td></tr><tr><td>Fh</td><td>Broadcast</td><td>Broadcast to chiplets [8:0]</td></tr></table> | Value                       | Name | Description | 8h-0h | 8-0 | Chiplet <Value> | Fh | Broadcast | Broadcast to chiplets [8:0] |
| Value                    | Name                                                                                                                                                                                                                                                 | Description                 |      |             |       |     |                 |    |           |                             |
| 8h-0h                    | 8-0                                                                                                                                                                                                                                                  | Chiplet <Value>             |      |             |       |     |                 |    |           |                             |
| Fh                       | Broadcast                                                                                                                                                                                                                                            | Broadcast to chiplets [8:0] |      |             |       |     |                 |    |           |                             |
| D18F2x98_dct[3:0][19:16] | 1h                                                                                                                                                                                                                                                   |                             |      |             |       |     |                 |    |           |                             |
| D18F2x98_dct[3:0][15:12] | <b>Txpad: Tx pad selector.</b> See: Table 146 [Address Mapping for D18F2x9C_x0[3,1:0][F,3:0]0_[F,B:0]041_dct[3:0]].                                                                                                                                  |                             |      |             |       |     |                 |    |           |                             |
| D18F2x98_dct[3:0][11:0]  | 041h                                                                                                                                                                                                                                                 |                             |      |             |       |     |                 |    |           |                             |
| D18F1x10C[DctCfgSel]     | <b>dct: DCT controller select.</b> See: Table 146 [Address Mapping for D18F2x9C_x0[3,1:0][F,3:0]0_[F,B:0]041_dct[3:0]].                                                                                                                              |                             |      |             |       |     |                 |    |           |                             |

| Bits  | Description |
|-------|-------------|
| 31:14 | Reserved.   |

|      |                                                                                                                                   |                    |             |                    |
|------|-----------------------------------------------------------------------------------------------------------------------------------|--------------------|-------------|--------------------|
| 13:7 | <b>DrvStrenN: NMOS driver output impedance.</b> Read-write. BIOS: See 2.9.9.2.5. Specifies the pull-up output driver impedance.   |                    |             |                    |
| 6:0  | <b>DrvStrenP: PMOS driver output impedance.</b> Read-write. BIOS: See 2.9.9.2.5. Specifies the pull-down output driver impedance. |                    |             |                    |
|      | <u>Bits</u>                                                                                                                       | <u>Description</u> | <u>Bits</u> | <u>Description</u> |
|      | 00h                                                                                                                               | disabled           | 34h         | 48 ohms            |
|      | 01h                                                                                                                               | 480 ohms           | 35h         | 43.6 ohms          |
|      | 04h                                                                                                                               | 240 ohms           | 70h         | 40 ohms            |
|      | 05h                                                                                                                               | 160 ohms           | 71h         | 36.9 ohms          |
|      | 0Ch                                                                                                                               | 120 ohms           | 74h         | 34.3 ohms          |
|      | 0Dh                                                                                                                               | 96 ohms            | 75h         | 32 ohms            |
|      | 0Fh                                                                                                                               | 80 ohms            | 7Ch         | 30 ohms            |
|      | 15h                                                                                                                               | 68 ohms            | 7Dh         | 28.2 ohms          |
|      | 30h                                                                                                                               | 60 ohms            | 7Fh         | 26.7 ohms          |
|      | 31h                                                                                                                               | 53.3 ohms          |             |                    |

### D18F2x9C\_x0[3,1:0][F,8:0]1\_[F,7:0]043\_dct[3:0] DATA Rcv Majormode

Cold reset: 0000\_xxxxh. See 2.9.4.1 for chiplet to pin mapping.

Table 164: Address Mapping for D18F2x9C\_x0[3,1:0][F,8:0]1\_[F,7:0]043\_dct[3:0]

| Address                  | Description                                                                                                                                                                                                                                                               |                             |             |                    |       |     |                 |    |           |                             |
|--------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|-------------|--------------------|-------|-----|-----------------|----|-----------|-----------------------------|
| PciCfgDevFunc[11:0]      | 182h                                                                                                                                                                                                                                                                      |                             |             |                    |       |     |                 |    |           |                             |
| PciCfgOffset[11:0]       | 09Ch                                                                                                                                                                                                                                                                      |                             |             |                    |       |     |                 |    |           |                             |
| D18F2x98_dct[3:0][31:28] | 0h                                                                                                                                                                                                                                                                        |                             |             |                    |       |     |                 |    |           |                             |
| D18F2x98_dct[3:0][27:24] | <b>mp: memory P-state selector.</b> See: Table 146 [Address Mapping for D18F2x9C_x0[3,1:0][F,3:0]0_[F,B:0]041_dct[3:0]].                                                                                                                                                  |                             |             |                    |       |     |                 |    |           |                             |
| D18F2x98_dct[3:0][23:20] | <b>chiplet: chiplet selector.</b> <table><tr><th><u>Value</u></th><th><u>Name</u></th><th><u>Description</u></th></tr><tr><td>8h-0h</td><td>8-0</td><td>Chiplet &lt;Value&gt;</td></tr><tr><td>Fh</td><td>Broadcast</td><td>Broadcast to chiplets [8:0]</td></tr></table> | <u>Value</u>                | <u>Name</u> | <u>Description</u> | 8h-0h | 8-0 | Chiplet <Value> | Fh | Broadcast | Broadcast to chiplets [8:0] |
| <u>Value</u>             | <u>Name</u>                                                                                                                                                                                                                                                               | <u>Description</u>          |             |                    |       |     |                 |    |           |                             |
| 8h-0h                    | 8-0                                                                                                                                                                                                                                                                       | Chiplet <Value>             |             |                    |       |     |                 |    |           |                             |
| Fh                       | Broadcast                                                                                                                                                                                                                                                                 | Broadcast to chiplets [8:0] |             |                    |       |     |                 |    |           |                             |
| D18F2x98_dct[3:0][19:16] | 1h                                                                                                                                                                                                                                                                        |                             |             |                    |       |     |                 |    |           |                             |
| D18F2x98_dct[3:0][15:12] | <b>bit: pad selector.</b> <table><tr><th><u>Value</u></th><th><u>Name</u></th><th><u>Description</u></th></tr><tr><td>7h-0h</td><td>7-0</td><td>Bit &lt;Value&gt;</td></tr><tr><td>Fh</td><td>Broadcast</td><td>Broadcast to bits [7:0]</td></tr></table>                 | <u>Value</u>                | <u>Name</u> | <u>Description</u> | 7h-0h | 7-0 | Bit <Value>     | Fh | Broadcast | Broadcast to bits [7:0]     |
| <u>Value</u>             | <u>Name</u>                                                                                                                                                                                                                                                               | <u>Description</u>          |             |                    |       |     |                 |    |           |                             |
| 7h-0h                    | 7-0                                                                                                                                                                                                                                                                       | Bit <Value>                 |             |                    |       |     |                 |    |           |                             |
| Fh                       | Broadcast                                                                                                                                                                                                                                                                 | Broadcast to bits [7:0]     |             |                    |       |     |                 |    |           |                             |
| D18F2x98_dct[3:0][11:0]  | 043h                                                                                                                                                                                                                                                                      |                             |             |                    |       |     |                 |    |           |                             |
| D18F1x10C[DctCfgSel]     | <b>dct: DCT controller select.</b> See: Table 146 [Address Mapping for D18F2x9C_x0[3,1:0][F,3:0]0_[F,B:0]041_dct[3:0]].                                                                                                                                                   |                             |             |                    |       |     |                 |    |           |                             |

| Bits        | Description                                                    |
|-------------|----------------------------------------------------------------|
| 31:3        | Reserved.                                                      |
| 2:0         | <b>MajorMode: Rx Major mode.</b> Read-write. BIOS: See 2.9.9.9 |
| <u>Bits</u> | <u>Description</u>                                             |
| 000b        | DDR3 normal                                                    |
| 011b-001b   | Reserved                                                       |
| 100b        | DDR3 low power                                                 |
| 111b-101b   | Reserved                                                       |

#### **D18F2x9C\_x0[3,1:0][F,8:0]1\_[F,7:0]045\_dct[3:0] DATA VrefNom**

Cold reset: 0000\_xxxxh. See 2.9.4.1 for chiplet to pin mapping.

Table 165: Address Mapping for D18F2x9C\_x0[3,1:0][F,8:0]1\_[F,7:0]045\_dct[3:0]

| Address                  | Description                                                                                                                                                                                                                                          |                             |      |             |       |     |                 |    |           |                             |
|--------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|------|-------------|-------|-----|-----------------|----|-----------|-----------------------------|
| PciCfgDevFunc[11:0]      | 182h                                                                                                                                                                                                                                                 |                             |      |             |       |     |                 |    |           |                             |
| PciCfgOffset[11:0]       | 09Ch                                                                                                                                                                                                                                                 |                             |      |             |       |     |                 |    |           |                             |
| D18F2x98_dct[3:0][31:28] | 0h                                                                                                                                                                                                                                                   |                             |      |             |       |     |                 |    |           |                             |
| D18F2x98_dct[3:0][27:24] | <b>mp: memory P-state selector.</b> See: Table 146 [Address Mapping for D18F2x9C_x0[3,1:0][F,3:0]0_[F,B:0]041_dct[3:0]].                                                                                                                             |                             |      |             |       |     |                 |    |           |                             |
| D18F2x98_dct[3:0][23:20] | <b>chiplet: chiplet selector.</b> <table><tr><th>Value</th><th>Name</th><th>Description</th></tr><tr><td>8h-0h</td><td>8-0</td><td>Chiplet &lt;Value&gt;</td></tr><tr><td>Fh</td><td>Broadcast</td><td>Broadcast to chiplets [8:0]</td></tr></table> | Value                       | Name | Description | 8h-0h | 8-0 | Chiplet <Value> | Fh | Broadcast | Broadcast to chiplets [8:0] |
| Value                    | Name                                                                                                                                                                                                                                                 | Description                 |      |             |       |     |                 |    |           |                             |
| 8h-0h                    | 8-0                                                                                                                                                                                                                                                  | Chiplet <Value>             |      |             |       |     |                 |    |           |                             |
| Fh                       | Broadcast                                                                                                                                                                                                                                            | Broadcast to chiplets [8:0] |      |             |       |     |                 |    |           |                             |
| D18F2x98_dct[3:0][19:16] | 1h                                                                                                                                                                                                                                                   |                             |      |             |       |     |                 |    |           |                             |
| D18F2x98_dct[3:0][15:12] | <b>bit: pad selector.</b> <table><tr><th>Value</th><th>Name</th><th>Description</th></tr><tr><td>7h-0h</td><td>7-0</td><td>Bit &lt;Value&gt;</td></tr><tr><td>Fh</td><td>Broadcast</td><td>Broadcast to bits [7:0]</td></tr></table>                 | Value                       | Name | Description | 7h-0h | 7-0 | Bit <Value>     | Fh | Broadcast | Broadcast to bits [7:0]     |
| Value                    | Name                                                                                                                                                                                                                                                 | Description                 |      |             |       |     |                 |    |           |                             |
| 7h-0h                    | 7-0                                                                                                                                                                                                                                                  | Bit <Value>                 |      |             |       |     |                 |    |           |                             |
| Fh                       | Broadcast                                                                                                                                                                                                                                            | Broadcast to bits [7:0]     |      |             |       |     |                 |    |           |                             |
| D18F2x98_dct[3:0][11:0]  | 045h                                                                                                                                                                                                                                                 |                             |      |             |       |     |                 |    |           |                             |
| D18F1x10C[DctCfgSel]     | <b>dct: DCT controller select.</b> See: Table 146 [Address Mapping for D18F2x9C_x0[3,1:0][F,3:0]0_[F,B:0]041_dct[3:0]].                                                                                                                              |                             |      |             |       |     |                 |    |           |                             |

| Bits | Description                                              |
|------|----------------------------------------------------------|
| 31:7 | Reserved.                                                |
| 6:0  | <b>VrefDnom: Rx Vref nominal.</b> Read-write. BIOS: 40h. |

#### **D18F2x9C\_x0[3,1:0][F,8:0]1\_[F,B:0]046\_dct[3:0] DATA Tx EQ HI Impedance**

Cold reset: 0000\_0000h. See 2.9.4.1 for chiplet to pin mapping.

Table 166: Address Mapping for D18F2x9C\_x0[3,1:0][F,8:0]1\_[F,B:0]046\_dct[3:0]

| Address                  | Description                                                                                                              |
|--------------------------|--------------------------------------------------------------------------------------------------------------------------|
| PciCfgDevFunc[11:0]      | 182h                                                                                                                     |
| PciCfgOffset[11:0]       | 09Ch                                                                                                                     |
| D18F2x98_dct[3:0][31:28] | 0h                                                                                                                       |
| D18F2x98_dct[3:0][27:24] | <b>mp: memory P-state selector.</b> See: Table 146 [Address Mapping for D18F2x9C_x0[3,1:0][F,3:0]0_[F,B:0]041_dct[3:0]]. |
| D18F2x98_dct[3:0][23:20] | <b>chiplet: chiplet selector.</b> See: Table 163 [Address Mapping for D18F2x9C_x0[3,1:0][F,8:0]1_[F,B:0]041_dct[3:0]].   |
| D18F2x98_dct[3:0][19:16] | 1h                                                                                                                       |
| D18F2x98_dct[3:0][15:12] | <b>Txpad: Tx pad selector.</b> See: Table 146 [Address Mapping for D18F2x9C_x0[3,1:0][F,3:0]0_[F,B:0]041_dct[3:0]].      |
| D18F2x98_dct[3:0][11:0]  | 046h                                                                                                                     |
| D18F1x10C[DctCfgSel]     | <b>dct: DCT controller select.</b> See: Table 146 [Address Mapping for D18F2x9C_x0[3,1:0][F,3:0]0_[F,B:0]041_dct[3:0]].  |

| Bits  | Description                                                                                                                                                               |
|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:14 | Reserved.                                                                                                                                                                 |
| 13:7  | <b>EQStrenHiN: Equalization HI NMOS driver output impedance.</b> Read-write. BIOS: See 2.9.9.2.10. Specifies the pulldown output driver impedance during Hi de-emphasis . |
| 6:0   | <b>EQStrenHiP: Equalization HI PMOS driver output impedance.</b> Read-write. BIOS: See 2.9.9.2.10. Specifies the pullup output driver impedance during Hi de-emphasis .   |

**D18F2x9C\_x0[3,1:0][F,8:0]1\_[F,B:0]047\_dct[3:0] DATA Tx EQ LO Impedance**

Cold reset: 0000\_0000h. See 2.9.4.1 for chiplet to pin mapping.

Table 167: Address Mapping for D18F2x9C\_x0[3,1:0][F,8:0]1\_[F,B:0]047\_dct[3:0]

| Address                  | Description                                                                                                              |
|--------------------------|--------------------------------------------------------------------------------------------------------------------------|
| PciCfgDevFunc[11:0]      | 182h                                                                                                                     |
| PciCfgOffset[11:0]       | 09Ch                                                                                                                     |
| D18F2x98_dct[3:0][31:28] | 0h                                                                                                                       |
| D18F2x98_dct[3:0][27:24] | <b>mp: memory P-state selector.</b> See: Table 146 [Address Mapping for D18F2x9C_x0[3,1:0][F,3:0]0_[F,B:0]041_dct[3:0]]. |
| D18F2x98_dct[3:0][23:20] | <b>chiplet: chiplet selector.</b> See: Table 163 [Address Mapping for D18F2x9C_x0[3,1:0][F,8:0]1_[F,B:0]041_dct[3:0]].   |
| D18F2x98_dct[3:0][19:16] | 1h                                                                                                                       |
| D18F2x98_dct[3:0][15:12] | <b>Txpad: Tx pad selector.</b> See: Table 146 [Address Mapping for D18F2x9C_x0[3,1:0][F,3:0]0_[F,B:0]041_dct[3:0]].      |
| D18F2x98_dct[3:0][11:0]  | 047h                                                                                                                     |
| D18F1x10C[DctCfgSel]     | <b>dct: DCT controller select.</b> See: Table 146 [Address Mapping for D18F2x9C_x0[3,1:0][F,3:0]0_[F,B:0]041_dct[3:0]].  |

| Bits  | Description                                                                                                                                                                                |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:14 | Reserved.                                                                                                                                                                                  |
| 13:7  | <b>EQStrenLoN: Equalization LO NMOS driver output impedance.</b> Read-write. BIOS: See <a href="#">2.9.9.2.10</a> . Specifies the pulldown output driver impedance during Lo de-emphasis . |
| 6:0   | <b>EQStrenLoP: Equalization LO PMOS driver output impedance.</b> Read-write. BIOS: See <a href="#">2.9.9.2.10</a> . Specifies the pullup output driver impedance during Lo de-emphasis .   |

#### **D18F2x9C\_x0[3,1:0][F,8:0]1\_[F,B:0]048\_dct[3:0] DATA Tx EQ Boost Impedance**

Cold reset: 0000\_0000h. See [2.9.4.1](#) for chiplet to pin mapping.

Table 168: Address Mapping for [D18F2x9C\\_x0\[3,1:0\]\[F,8:0\]1\\_\[F,B:0\]048\\_dct\[3:0\]](#)

| Address                                  | Description                                                                                                                               |
|------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|
| PciCfgDevFunc[11:0]                      | 182h                                                                                                                                      |
| PciCfgOffset[11:0]                       | 09Ch                                                                                                                                      |
| <a href="#">D18F2x98_dct[3:0][31:28]</a> | 0h                                                                                                                                        |
| <a href="#">D18F2x98_dct[3:0][27:24]</a> | <b>mp: memory P-state selector.</b> See: Table 146 [Address Mapping for <a href="#">D18F2x9C_x0[3,1:0][F,3:0]0_[F,B:0]041_dct[3:0]</a> ]. |
| <a href="#">D18F2x98_dct[3:0][23:20]</a> | <b>chiplet: chiplet selector.</b> See: Table 163 [Address Mapping for <a href="#">D18F2x9C_x0[3,1:0][F,8:0]1_[F,B:0]041_dct[3:0]</a> ].   |
| <a href="#">D18F2x98_dct[3:0][19:16]</a> | 1h                                                                                                                                        |
| <a href="#">D18F2x98_dct[3:0][15:12]</a> | <b>Txpad: Tx pad selector.</b> See: Table 146 [Address Mapping for <a href="#">D18F2x9C_x0[3,1:0][F,3:0]0_[F,B:0]041_dct[3:0]</a> ].      |
| <a href="#">D18F2x98_dct[3:0][11:0]</a>  | 047h                                                                                                                                      |
| <a href="#">D18F1x10C[DctCfgSel]</a>     | <b>dct: DCT controller select.</b> See: Table 146 [Address Mapping for <a href="#">D18F2x9C_x0[3,1:0][F,3:0]0_[F,B:0]041_dct[3:0]</a> ].  |

| Bits  | Description                                                                                                                                                                          |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:14 | Reserved.                                                                                                                                                                            |
| 13:7  | <b>BoostStrenN: Equalization Boost driver output impedance.</b> Read-write. BIOS: See <a href="#">2.9.9.2.10</a> . Specifies the boost impedance during rise or fall data bit times. |
| 6:0   | <b>BoostStrenP: Equalization Boost driver output impedance.</b> Read-write. BIOS: See <a href="#">2.9.9.2.10</a> . Specifies the boost impedance during rise or fall data bit times. |

#### **D18F2x9C\_x00[F,8:0]1\_[F,B:0]04A\_dct[3:0] DqDqs Rx Control**

Cold reset: 0000\_0200h. See [2.9.4.1](#) for chiplet to pin mapping.

Table 169: Index Mapping for [D18F2x9C\\_x00\[F,8:0\]1\\_\[F,B:0\]04A\\_dct\[3:0\]](#)

| Address Bits | Valid Values | Name |
|--------------|--------------|------|
|--------------|--------------|------|

Table 169: Index Mapping for D18F2x9C\_x00[F,8:0]1\_[F,B:0]04A\_dct[3:0]

|                          |       |                    |
|--------------------------|-------|--------------------|
| D18F2x98_dct[3:0][15:12] | [B:0] | Rx pad             |
| D18F2x98_dct[3:0][15:12] | Fh    | Rx pad [B:0]       |
| D18F2x98_dct[3:0][23:20] | [8:0] | Data chiplet       |
| D18F2x98_dct[3:0][23:20] | Fh    | Data chiplet [8:0] |

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |      |             |    |               |    |               |       |          |
|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|----|---------------|----|---------------|-------|----------|
| 31:10 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |      |             |    |               |    |               |       |          |
| 9     | <b>DisableFCPeaking: Disable FC Peaking.</b> Read-write. 1=Disable inductive-peaking for the folded-cascode gain stage of the DQ receiver.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |      |             |    |               |    |               |       |          |
| 8     | <b>BiasBypassEn.</b> Read-write. See: D18F2x9C_x00[F,3:0]0_[F,B:0]04A_dct[3:0][8].                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |      |             |    |               |    |               |       |          |
| 7     | <b>PowerDownRcvr.</b> Read-write. See: D18F2x9C_x00[F,3:0]0_[F,B:0]04A_dct[3:0][7].                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |      |             |    |               |    |               |       |          |
| 6:4   | <b>MajorMode.</b> Read-write. See: D18F2x9C_x00[F,3:0]0_[F,B:0]04A_dct[3:0][6:4].                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |      |             |    |               |    |               |       |          |
| 3:0   | <b>FineDlyCtrl: Fine delay control.</b> Read-write. Specifies an untimed amount of delay that the DATA (includes both DQ and DQS/WCK) chiplet signals are delayed from the default setup time, in addition to the per-group DLL RxDly. When applied to a CSR for a data strobe pad, then this has the equivalent functionality of legacy receiver enable delay. When applied to a CSR for a DQ pad, then this has the equivalent functionality of legacy read DQS delay.<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>0h</td><td>Minimum delay</td></tr> <tr> <td>9h</td><td>Maximum delay</td></tr> <tr> <td>Fh-Ah</td><td>Reserved</td></tr> </table> | Bits | Description | 0h | Minimum delay | 9h | Maximum delay | Fh-Ah | Reserved |
| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |      |             |    |               |    |               |       |          |
| 0h    | Minimum delay                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |      |             |    |               |    |               |       |          |
| 9h    | Maximum delay                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |      |             |    |               |    |               |       |          |
| Fh-Ah | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |      |             |    |               |    |               |       |          |

**D18F2x9C\_x0[3,1:0][F,8:0]1\_[F,B:0]04D\_dct[3:0] DATA Rx Impedance**

Cold reset: 0000\_0000h. See 2.9.4.1 for chiplet to pad and pad to pin mapping.

Table 170: Address Mapping for D18F2x9C\_x0[3,1:0][F,8:0]1\_[F,B:0]04D\_dct[3:0]

| Address                  | Description                                                                                                              |
|--------------------------|--------------------------------------------------------------------------------------------------------------------------|
| PciCfgDevFunc[11:0]      | 182h                                                                                                                     |
| PciCfgOffset[11:0]       | 09Ch                                                                                                                     |
| D18F2x98_dct[3:0][31:28] | 0h                                                                                                                       |
| D18F2x98_dct[3:0][27:24] | <b>mp: memory P-state selector.</b> See: Table 146 [Address Mapping for D18F2x9C_x0[3,1:0][F,3:0]0_[F,B:0]041_dct[3:0]]. |
| D18F2x98_dct[3:0][23:20] | <b>chiplet: chiplet selector.</b> See: Table 163 [Address Mapping for D18F2x9C_x0[3,1:0][F,8:0]1_[F,B:0]041_dct[3:0]].   |
| D18F2x98_dct[3:0][19:16] | 1h                                                                                                                       |
| D18F2x98_dct[3:0][15:12] | <b>Rxpad: Rx pad selector.</b> See: Table 146 [Address Mapping for D18F2x9C_x0[3,1:0][F,3:0]0_[F,B:0]041_dct[3:0]].      |
| D18F2x98_dct[3:0][11:0]  | 04Dh                                                                                                                     |
| D18F1x10C[DctCfgSel]     | <b>dct: DCT controller select.</b> See: Table 146 [Address Mapping for D18F2x9C_x0[3,1:0][F,3:0]0_[F,B:0]041_dct[3:0]].  |



| Bits | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |      |             |    |          |    |          |    |          |    |          |    |          |    |         |    |         |
|------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|----|----------|----|----------|----|----------|----|----------|----|----------|----|---------|----|---------|
| 31:8 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |      |             |    |          |    |          |    |          |    |          |    |          |    |         |    |         |
| 7:4  | <b>ODTStrenN: ODT strength NMOS.</b> Read-write. BIOS: See 2.9.9.2.5. Specifies the ODT impedance when in thevinin termination mode. See ODTStrenP for field description.                                                                                                                                                                                                                                                                                                                                                          |      |             |    |          |    |          |    |          |    |          |    |          |    |         |    |         |
| 3:0  | <b>ODTStrenP: ODT strength PMOS.</b> Read-write. BIOS: See 2.9.9.2.5. Specifies the ODT impedance when in thevinin termination mode. Note legacy ProcOdt values are given in Thevenin. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>0h</td><td>disabled</td></tr> <tr> <td>1h</td><td>480 ohms</td></tr> <tr> <td>4h</td><td>240 ohms</td></tr> <tr> <td>5h</td><td>160 ohms</td></tr> <tr> <td>Ch</td><td>120 ohms</td></tr> <tr> <td>Dh</td><td>96 ohms</td></tr> <tr> <td>Fh</td><td>80 ohms</td></tr> </table> | Bits | Description | 0h | disabled | 1h | 480 ohms | 4h | 240 ohms | 5h | 160 ohms | Ch | 120 ohms | Dh | 96 ohms | Fh | 80 ohms |
| Bits | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |      |             |    |          |    |          |    |          |    |          |    |          |    |         |    |         |
| 0h   | disabled                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |      |             |    |          |    |          |    |          |    |          |    |          |    |         |    |         |
| 1h   | 480 ohms                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |      |             |    |          |    |          |    |          |    |          |    |          |    |         |    |         |
| 4h   | 240 ohms                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |      |             |    |          |    |          |    |          |    |          |    |          |    |         |    |         |
| 5h   | 160 ohms                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |      |             |    |          |    |          |    |          |    |          |    |          |    |         |    |         |
| Ch   | 120 ohms                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |      |             |    |          |    |          |    |          |    |          |    |          |    |         |    |         |
| Dh   | 96 ohms                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |      |             |    |          |    |          |    |          |    |          |    |          |    |         |    |         |
| Fh   | 80 ohms                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |      |             |    |          |    |          |    |          |    |          |    |          |    |         |    |         |

#### **D18F2x9C\_x00[F,8:0]1\_[F,B:0]04E\_dct[3:0] TxControlDq**

Cold reset: 0000\_0013h. See 2.9.4.1 for chiplet to pin mapping.

Table 171: Index Mapping for D18F2x9C\_x00[F,8:0]1\_[F,B:0]04E\_dct[3:0]

| Address Bits             | Valid Values | Name               |
|--------------------------|--------------|--------------------|
| D18F2x98_dct[3:0][15:12] | [B:0]        | pad                |
| D18F2x98_dct[3:0][15:12] | Fh           | pad [B:0]          |
| D18F2x98_dct[3:0][23:20] | [8:0]        | Data chiplet       |
| D18F2x98_dct[3:0][23:20] | Fh           | Data chiplet [8:0] |

| Bits  | Description                                                        |
|-------|--------------------------------------------------------------------|
| 31:13 | Reserved.                                                          |
| 12    | <b>EQEnable: Equalization enable.</b> Read-write. BIOS: 0.         |
| 11    | <b>DrvPwrGateEn: Powergate driver enable.</b> Read-write. BIOS: 1. |
| 10:0  | Reserved.                                                          |

#### **D18F2x9C\_x00[F,8:0]1\_[F,B:0]051\_dct[3:0] DqDqsRcvCntrl3**

Cold reset: 0000\_0052h. See 2.9.4.1 for chiplet to pad mapping and 2.9.4 for pad to pin mapping.

Table 172: Address Mapping for D18F2x9C\_x00[F,8:0]1\_[F,B:0]051\_dct[3:0]

| Address                  | Description                                                                                                            |
|--------------------------|------------------------------------------------------------------------------------------------------------------------|
| PciCfgDevFunc[11:0]      | 182h                                                                                                                   |
| PciCfgOffset[11:0]       | 09Ch                                                                                                                   |
| D18F2x98_dct[3:0][31:24] | 00h                                                                                                                    |
| D18F2x98_dct[3:0][23:20] | <b>chiplet: chiplet selector.</b> See: Table 163 [Address Mapping for D18F2x9C_x0[3,1:0][F,8:0]1_[F,B:0]041_dct[3:0]]. |

Table 172: Address Mapping for D18F2x9C\_x00[F,8:0]1\_[F,B:0]051\_dct[3:0]

|                          |                                                                                                                         |
|--------------------------|-------------------------------------------------------------------------------------------------------------------------|
| D18F2x98_dct[3:0][19:16] | 1h                                                                                                                      |
| D18F2x98_dct[3:0][15:12] | <b>Rxpad: Rx pad selector.</b> See: Table 146 [Address Mapping for D18F2x9C_x0[3,1:0][F,3:0]0_[F,B:0]041_dct[3:0]].     |
| D18F2x98_dct[3:0][11:0]  | 05Fh                                                                                                                    |
| D18F1x10C[DctCfgSel]     | <b>dct: DCT controller select.</b> See: Table 146 [Address Mapping for D18F2x9C_x0[3,1:0][F,3:0]0_[F,B:0]041_dct[3:0]]. |

| Bits | Description                                                                                                          |
|------|----------------------------------------------------------------------------------------------------------------------|
| 31:9 | Reserved.                                                                                                            |
| 8    | <b>RxPadStandbyEn: Rx pad standby enable.</b> Read-write. BIOS: 1. 1=Enables standby power savings for the receiver. |
| 7:0  | Reserved.                                                                                                            |

**D18F2x9C\_x00[F,8:0]1\_[F,B:0]05F\_dct[3:0] DATA Tx Slew Rate**

Cold reset: 0000\_03BFh. See 2.9.4.1 for chiplet to pad mapping and 2.9.4 for pad to pin mapping.

Table 173: Address Mapping for D18F2x9C\_x00[F,8:0]1\_[F,B:0]05F\_dct[3:0]

| Address                  | Description                                                                                                             |
|--------------------------|-------------------------------------------------------------------------------------------------------------------------|
| PciCfgDevFunc[11:0]      | 182h                                                                                                                    |
| PciCfgOffset[11:0]       | 09Ch                                                                                                                    |
| D18F2x98_dct[3:0][31:24] | 00h                                                                                                                     |
| D18F2x98_dct[3:0][23:20] | <b>chiplet: chiplet selector.</b> See: Table 163 [Address Mapping for D18F2x9C_x0[3,1:0][F,8:0]1_[F,B:0]041_dct[3:0]].  |
| D18F2x98_dct[3:0][19:16] | 1h                                                                                                                      |
| D18F2x98_dct[3:0][15:12] | <b>Txpad: Tx pad selector.</b> See: Table 146 [Address Mapping for D18F2x9C_x0[3,1:0][F,3:0]0_[F,B:0]041_dct[3:0]].     |
| D18F2x98_dct[3:0][11:0]  | 05Fh                                                                                                                    |
| D18F1x10C[DctCfgSel]     | <b>dct: DCT controller select.</b> See: Table 146 [Address Mapping for D18F2x9C_x0[3,1:0][F,3:0]0_[F,B:0]041_dct[3:0]]. |

| Bits | Description                                                                                                                                                                                |
|------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:7 | Reserved.                                                                                                                                                                                  |
| 6    | <b>G5Mode: Gddr5 mode.</b> Read-write. BIOS: See 2.9.9.2. 1=Driver is in GDDR5 mode. 0=Driver is in DDR3 mode. See 2.9 for product support.                                                |
| 5:3  | <b>TxPreN: NMOS predriver calibration code.</b> Read-write. BIOS: See 2.9.9.2.7. Specifies the falling edge slew rate of the transmit pad. 000b=Slowest slew rate. 111b=Fastest slew rate. |
| 2:0  | <b>TxPreP: PMOS predriver calibration code.</b> Read-write. BIOS: See 2.9.9.2.7. Specifies the rising edge slew rate of the transmit pad. 000b=Slowest slew rate. 111b=Fastest slew rate.  |

**D18F2x9C\_x00[F,8:0]1\_0[F,2:0]77\_dct[3:0] DllPowerdown**

Cold reset: 0000\_0000h. See 2.9.4.1 for chiplet to pad mapping and see 2.9.4 for pad to pin mapping.

Table 174: Address Mapping for D18F2x9C\_x00[F,8:0]1\_0[F,2:0]77\_dct[3:0]

| Address                  | Description                                                                                                                                                                                                                                                                                                                                              |                              |      |             |           |       |                 |    |           |                             |    |    |                              |    |     |                        |
|--------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|------|-------------|-----------|-------|-----------------|----|-----------|-----------------------------|----|----|------------------------------|----|-----|------------------------|
| PciCfgDevFunc[11:0]      | 182h                                                                                                                                                                                                                                                                                                                                                     |                              |      |             |           |       |                 |    |           |                             |    |    |                              |    |     |                        |
| PciCfgOffset[11:0]       | 09Ch                                                                                                                                                                                                                                                                                                                                                     |                              |      |             |           |       |                 |    |           |                             |    |    |                              |    |     |                        |
| D18F2x98_dct[3:0][31:24] | 00h                                                                                                                                                                                                                                                                                                                                                      |                              |      |             |           |       |                 |    |           |                             |    |    |                              |    |     |                        |
| D18F2x98_dct[3:0][23:20] | <b>chiplet: chiplet selector.</b> <table><tr><th>Value</th><th>Name</th><th>Description</th></tr><tr><td>8h-0h</td><td>8-0</td><td>Chiplet &lt;Value&gt;</td></tr><tr><td>Fh</td><td>Broadcast</td><td>Broadcast to chiplets [8:0]</td></tr></table>                                                                                                     | Value                        | Name | Description | 8h-0h     | 8-0   | Chiplet <Value> | Fh | Broadcast | Broadcast to chiplets [8:0] |    |    |                              |    |     |                        |
| Value                    | Name                                                                                                                                                                                                                                                                                                                                                     | Description                  |      |             |           |       |                 |    |           |                             |    |    |                              |    |     |                        |
| 8h-0h                    | 8-0                                                                                                                                                                                                                                                                                                                                                      | Chiplet <Value>              |      |             |           |       |                 |    |           |                             |    |    |                              |    |     |                        |
| Fh                       | Broadcast                                                                                                                                                                                                                                                                                                                                                | Broadcast to chiplets [8:0]  |      |             |           |       |                 |    |           |                             |    |    |                              |    |     |                        |
| D18F2x98_dct[3:0][19:12] | 10h                                                                                                                                                                                                                                                                                                                                                      |                              |      |             |           |       |                 |    |           |                             |    |    |                              |    |     |                        |
| D18F2x98_dct[3:0][11:8]  | <b>pad: pad selector.</b> <table><tr><th>Value</th><th>Name</th><th>Description</th></tr><tr><td>0h</td><td>0h</td><td>DQ[3:0] pads</td></tr><tr><td>1h</td><td>1h</td><td>DQ[7:4], MEMDQSDM[0] pads</td></tr><tr><td>2h</td><td>2h</td><td>MEMDQS_H[0]<sup>1</sup> pad</td></tr><tr><td>Fh</td><td>All</td><td>all pads (groups[2:0])</td></tr></table> | Value                        | Name | Description | 0h        | 0h    | DQ[3:0] pads    | 1h | 1h        | DQ[7:4], MEMDQSDM[0] pads   | 2h | 2h | MEMDQS_H[0] <sup>1</sup> pad | Fh | All | all pads (groups[2:0]) |
| Value                    | Name                                                                                                                                                                                                                                                                                                                                                     | Description                  |      |             |           |       |                 |    |           |                             |    |    |                              |    |     |                        |
| 0h                       | 0h                                                                                                                                                                                                                                                                                                                                                       | DQ[3:0] pads                 |      |             |           |       |                 |    |           |                             |    |    |                              |    |     |                        |
| 1h                       | 1h                                                                                                                                                                                                                                                                                                                                                       | DQ[7:4], MEMDQSDM[0] pads    |      |             |           |       |                 |    |           |                             |    |    |                              |    |     |                        |
| 2h                       | 2h                                                                                                                                                                                                                                                                                                                                                       | MEMDQS_H[0] <sup>1</sup> pad |      |             |           |       |                 |    |           |                             |    |    |                              |    |     |                        |
| Fh                       | All                                                                                                                                                                                                                                                                                                                                                      | all pads (groups[2:0])       |      |             |           |       |                 |    |           |                             |    |    |                              |    |     |                        |
| D18F2x98_dct[3:0][7:0]   | 78h                                                                                                                                                                                                                                                                                                                                                      |                              |      |             |           |       |                 |    |           |                             |    |    |                              |    |     |                        |
| D18F1x10C[DctCfgSel]     | <b>dct: DCT controller select.</b> <table><tr><th>Value</th><th>Name</th><th>Description</th></tr><tr><td>011b-000b</td><td>3h-0h</td><td>DCT &lt;Value&gt;</td></tr></table>                                                                                                                                                                            | Value                        | Name | Description | 011b-000b | 3h-0h | DCT <Value>     |    |           |                             |    |    |                              |    |     |                        |
| Value                    | Name                                                                                                                                                                                                                                                                                                                                                     | Description                  |      |             |           |       |                 |    |           |                             |    |    |                              |    |     |                        |
| 011b-000b                | 3h-0h                                                                                                                                                                                                                                                                                                                                                    | DCT <Value>                  |      |             |           |       |                 |    |           |                             |    |    |                              |    |     |                        |

1. MEMDQS\_H[0] is the positive polarity strobe pad for a x8 device. MEMDQSDM[0] is the data mask pin used in x8 or x16 devices.

| Bits  | Description                                                    |
|-------|----------------------------------------------------------------|
| 31:11 | Reserved.                                                      |
| 10:6  | <b>DllPowerDownTx: Dll power down transmitter.</b> Read-write. |
| 5     | <b>DllPowerDownXCLK: Dll power down XCLK.</b> Read-write.      |
| 4:1   | Reserved.                                                      |
| 0     | <b>DllPowerDown: Dll power down.</b> Read-write.               |

**D18F2x9C\_x00[F,8:0]1\_0[F,2:0]78\_dct[3:0] DllControl**

Cold reset: 0000\_0000h. See 2.9.4.1 for chiplet to pad mapping and see 2.9.4 for pad to pin mapping.

Table 175: Address Mapping for D18F2x9C\_x00[F,8:0]1\_0[F,2:0]78\_dct[3:0]

| Address                  | Description |
|--------------------------|-------------|
| PciCfgDevFunc[11:0]      | 182h        |
| PciCfgOffset[11:0]       | 09Ch        |
| D18F2x98_dct[3:0][31:24] | 00h         |

Table 175: Address Mapping for D18F2x9C\_x00[F,8:0]1\_0[F,2:0]78\_dct[3:0]

|                                                                                                                                 |                                    |             |                              |
|---------------------------------------------------------------------------------------------------------------------------------|------------------------------------|-------------|------------------------------|
| D18F2x98_dct[3:0][23:20]                                                                                                        | <b>chiplet: chiplet selector.</b>  |             |                              |
|                                                                                                                                 | <u>Value</u>                       | <u>Name</u> | <u>Description</u>           |
|                                                                                                                                 | 8h-0h                              | 8-0         | Chiplet <Value>              |
|                                                                                                                                 | Fh                                 | Broadcast   | Broadcast to chiplets [8:0]  |
| D18F2x98_dct[3:0][19:12]                                                                                                        | 10h                                |             |                              |
| D18F2x98_dct[3:0][11:8]                                                                                                         | <b>pad: pad selector.</b>          |             |                              |
|                                                                                                                                 | <u>Value</u>                       | <u>Name</u> | <u>Description</u>           |
|                                                                                                                                 | 0h                                 | 0h          | DQ[3:0] pads                 |
|                                                                                                                                 | 1h                                 | 1h          | DQ[7:4], MEMDQSDM[0] pads    |
|                                                                                                                                 | 2h                                 | 2h          | MEMDQS_H[0] <sup>1</sup> pad |
|                                                                                                                                 | Fh                                 | All         | all pads (groups[2:0])       |
| D18F2x98_dct[3:0][7:0]                                                                                                          | 78h                                |             |                              |
| D18F1x10C[DctCfgSel]                                                                                                            | <b>dct: DCT controller select.</b> |             |                              |
|                                                                                                                                 | <u>Value</u>                       | <u>Name</u> | <u>Description</u>           |
|                                                                                                                                 | 011b-000b                          | 3h-0h       | DCT <Value>                  |
| 1. MEMDQS_H[0] is the positive polarity strobe pad for a x8 device. MEMDQSDM[0] is the data mask pin used in x8 or x16 devices. |                                    |             |                              |

| Bits | Description                                                                                                                                                                             |
|------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:8 | Reserved.                                                                                                                                                                               |
| 7    | <b>DllResetRelock: Dll reset relock.</b> Read-write. 1=Reset the DLL. 0=Relock the DLL. This bit must be set for 20 ns and then cleared anytime a forced relock of the DLL is required. |
| 6:0  | Reserved.                                                                                                                                                                               |

**D18F2x9C\_x0[F,1:0][F,8:0]1\_[F,9:0][F,3:0]80\_dct[3:0] Rx Delay**

Cold reset: 0000\_0040h. See 2.9.4.1 for chiplet to pad mapping and see 2.9.4 for pad to pin mapping.

Table 176: Address Mapping for D18F2x9C\_x0[F,1:0][F,8:0]1\_[F,9:0][F,3:0]80\_dct[3:0]

| Address                  | Description                                               |
|--------------------------|-----------------------------------------------------------|
| PciCfgDevFunc[11:0]      | 182h                                                      |
| PciCfgOffset[11:0]       | 09Ch                                                      |
| D18F2x98_dct[3:0][31:28] | 0h                                                        |
| D18F2x98_dct[3:0][27:24] | <b>mp: memory P-state selector.</b>                       |
|                          | <u>Value</u> <u>Name</u> <u>Description</u>               |
|                          | 1h-0h      1h-0h      Memory P-state <Value>              |
|                          | Fh      Broadcast      Broadcast to Memory P-states [1:0] |
| D18F2x98_dct[3:0][23:20] | <b>chiplet: chiplet selector.</b>                         |
|                          | <u>Value</u> <u>Name</u> <u>Description</u>               |
|                          | 8h-0h      8-0      Chiplet <Value>                       |
|                          | Fh      Broadcast      Broadcast to chiplets [8:0]        |
| D18F2x98_dct[3:0][19:16] | 1h                                                        |

Table 176: Address Mapping for D18F2x9C\_x0[F,1:0][F,8:0]1\_[F,9:0][F,3:0]80\_dct[3:0]

|                                                                                                                                                                                                                                                                                           |                                    |             |                              |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------|-------------|------------------------------|
| D18F2x98_dct[3:0][15:12]                                                                                                                                                                                                                                                                  | <b>pad: pad selector.</b>          |             |                              |
|                                                                                                                                                                                                                                                                                           | <u>Value</u>                       | <u>Name</u> | <u>Description</u>           |
|                                                                                                                                                                                                                                                                                           | 0h                                 | 0h          | DQ[3:0] pads                 |
|                                                                                                                                                                                                                                                                                           | 1h                                 | 1h          | DQ[7:4] pads                 |
|                                                                                                                                                                                                                                                                                           | 2h                                 | 2h          | MEMDQS_H[0] <sup>2</sup> pad |
|                                                                                                                                                                                                                                                                                           | Fh                                 | All         | all pads (k group[3:0])      |
| D18F2x98_dct[3:0][11:8]                                                                                                                                                                                                                                                                   | <b>dimm: dimm selector.</b>        |             |                              |
|                                                                                                                                                                                                                                                                                           | <u>Value</u>                       | <u>Name</u> | <u>Description</u>           |
|                                                                                                                                                                                                                                                                                           | 3h-0h                              | 3h-0h       | dimm <Value>                 |
|                                                                                                                                                                                                                                                                                           | Fh                                 | Broadcast   | Broadcast to all dimms [3:0] |
| D18F2x98_dct[3:0][7:0]                                                                                                                                                                                                                                                                    | 80h                                |             |                              |
| D18F1x10C[DctCfgSel]                                                                                                                                                                                                                                                                      | <b>dct: DCT controller select.</b> |             |                              |
|                                                                                                                                                                                                                                                                                           | <u>Value</u>                       | <u>dct</u>  | <u>Description</u>           |
|                                                                                                                                                                                                                                                                                           | 011b-000b                          | 3h-0h       | DCT <dct>                    |
| <ol style="list-style-type: none"> <li>1. If D18F2xA8_dct[3:0][PerRankTimingEn]=1 then each CSR addressed with DIMM controls the corresponding numbered chipselect, up to four total chipselects.</li> <li>2. MEMDQS_H[0] is the positive polarity strobe pad for a x8 device.</li> </ol> |                                    |             |                              |

| Bits | Description                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:8 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 7:0  | <b>RxDly: Rx delay.</b> Read-write. BIOS: See 2.9.9.2.10. Specifies the time that the DATA (includes both DQ and DQS/WCK) chiplet signals are delayed from the default setup time, in increments of 1/32UI. When applied to a CSR for a data strobe pad, then this has the equivalent functionality of legacy receiver enable delay. When applied to a CSR for a DQ pad, then this has the equivalent functionality of legacy read DQS delay. |

**D18F2x9C\_x0[F,1:0][F,8:0]1\_[F,9:0][F,3:0]81\_dct[3:0] Tx Delay**

Cold reset: 0000\_0000h. See 2.9.4.1 for chiplet to pad mapping and see 2.9.4 for pad to pin mapping.

Table 177: Address Mapping for D18F2x9C\_x0[F,1:0][F,8:0]1\_[F,9:0][F,3:0]81\_dct[3:0]

| Address                  | Description                                               |
|--------------------------|-----------------------------------------------------------|
| PciCfgDevFunc[11:0]      | 182h                                                      |
| PciCfgOffset[11:0]       | 09Ch                                                      |
| D18F2x98_dct[3:0][31:28] | 0h                                                        |
| D18F2x98_dct[3:0][27:24] | <b>mp: memory P-state selector.</b>                       |
|                          | <u>Value</u> <u>Name</u> <u>Description</u>               |
|                          | 1h-0h      1h-0h      Memory P-state <Value>              |
|                          | Fh      Broadcast      Broadcast to Memory P-states [1:0] |
| D18F2x98_dct[3:0][23:20] | <b>chiplet: chiplet selector.</b>                         |
|                          | <u>Value</u> <u>Name</u> <u>Description</u>               |
|                          | 8h-0h      8-0      Chiplet <Value>                       |
|                          | Fh      Broadcast      Broadcast to chiplets [8:0]        |
| D18F2x98_dct[3:0][19:16] | 1h                                                        |

Table 177: Address Mapping for D18F2x9C\_x0[F,1:0][F,8:0]1\_[F,9:0][F,3:0]81\_dct[3:0]

|                                                                                                                                                                                                                                                                                                                                                       |                                    |             |                                 |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------|-------------|---------------------------------|
| D18F2x98_dct[3:0][15:12]                                                                                                                                                                                                                                                                                                                              | <b>pad: pad selector.</b>          |             |                                 |
|                                                                                                                                                                                                                                                                                                                                                       | <u>Value</u>                       | <u>Name</u> | <u>Description</u>              |
|                                                                                                                                                                                                                                                                                                                                                       | 0h                                 | 0h          | DQ[3:0] pads                    |
|                                                                                                                                                                                                                                                                                                                                                       | 1h                                 | 1h          | DQ[7:4], MEMDQSDM[0] pads       |
|                                                                                                                                                                                                                                                                                                                                                       | 2h                                 | 2h          | MEMDQS_H[0] <sup>2</sup> pad    |
|                                                                                                                                                                                                                                                                                                                                                       | Fh                                 | All         | all pads (k group[3:0])         |
| D18F2x98_dct[3:0][11:8]                                                                                                                                                                                                                                                                                                                               | <b>dimmm: dimm selector.</b>       |             |                                 |
|                                                                                                                                                                                                                                                                                                                                                       | <u>Value</u>                       | <u>Name</u> | <u>Description</u> <sup>1</sup> |
|                                                                                                                                                                                                                                                                                                                                                       | 3h-0h                              | 3h-0h       | dimm <Value>                    |
|                                                                                                                                                                                                                                                                                                                                                       | Fh                                 | Broadcast   | Broadcast to all dimms [3:0]    |
| D18F2x98_dct[3:0][7:0]                                                                                                                                                                                                                                                                                                                                | 81h                                |             |                                 |
| D18F1x10C[DctCfgSel]                                                                                                                                                                                                                                                                                                                                  | <b>dct: DCT controller select.</b> |             |                                 |
|                                                                                                                                                                                                                                                                                                                                                       | <u>Value</u>                       | <u>Name</u> | <u>Description</u>              |
|                                                                                                                                                                                                                                                                                                                                                       | 011b-000b                          | 3h-0h       | DCT <Value>                     |
| <ol style="list-style-type: none"> <li>1. If D18F2xA8_dct[3:0][PerRankTimingEn]=1 then each CSR addressed with DIMM controls the corresponding numbered chipselect, up to four total chipselects.</li> <li>2. MEMDQS_H[0] is the positive polarity strobe pad for a x8 device. MEMDQSDM[0] is the data mask pin used in x8 or x16 devices.</li> </ol> |                                    |             |                                 |

| Bits | Description                                                                                                                                                                                                                                                                                                                                                                                                                              |
|------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:8 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                |
| 7:0  | <b>TxDly: Tx delay.</b> Read-write. BIOS: See 2.9.9.2.10. Specifies the time that the DATA (includes both DQ and DQS/WCK) chip signals are delayed from the default setup time, in increments of 1/32 UI. When applied to a CSR for a write strobe pad, then this has the equivalent functionality of legacy write DQS delay. When applied to a CSR for a DQ pad, then this has the equivalent functionality of legacy write data delay. |

**D18F2x9C\_x0002\_0000\_dct[3:0] PLL MemoryPstate0**

Cold reset: 0000\_0400h.

Table 178: Index Mapping for PLLMultDiv Value Definition

| Bits  | Data Rate |
|-------|-----------|
| 0603h | 667 MT/s  |
| 0D01h | 1333 MT/s |
| 1000h | 1600 MT/s |
| 1203h | 1866 MT/s |
| 1501h | 2133 MT/s |
| 1800h | 2400 MT/s |
| 2000h | 3200 MT/s |
| 2200h | 3400 MT/s |

Note: “Memory-Clock” frequency is one-half of the data rate for DDR3.

| Bits  | Description                                                                                                                                                                                                                    |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:16 | Reserved.                                                                                                                                                                                                                      |
| 15:0  | <b>PllMultDiv: Pll multiplier divider.</b> Read-write. BIOS: <a href="#">2.9.9.2.3</a> . Specifies the DRAM bus data rate for DDR3 memory P-state 0, by way of phy Pll multiplier and divider. See <a href="#">Table 178</a> . |

#### **D18F2x9C\_x0002\_0001\_dct[3:0] Pll MemoryPstate1**

Cold reset: 0000\_0400h.

| Bits  | Description                                                                                                                                                                                                              |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:16 | Reserved.                                                                                                                                                                                                                |
| 15:0  | <b>PllMultDiv: Pll multiplier divider.</b> Read-write. BIOS: <a href="#">2.9.9.2.3</a> . Specifies the DRAM bus data rate for memory P-state 1 by way of phy Pll multiplier and divider. See <a href="#">Table 178</a> . |

#### **D18F2x9C\_x0002\_0004\_dct[3:0] Mailbox Protocol Shadow**

Cold reset: 0000\_0007h.

| Bits | Description                                                                                                                     |
|------|---------------------------------------------------------------------------------------------------------------------------------|
| 31:3 | Reserved.                                                                                                                       |
| 2    | <b>Us2Rdy: Upstream 2 Ready.</b> Read-only. This bit is a read-only copy of <a href="#">D18F2x9C_x0002_0035_dct[3:0][Rdy]</a> . |
| 1    | <b>UsRdy: Upstream Ready.</b> Read-only. This bit is a read-only copy of <a href="#">D18F2x9C_x0002_0033_dct[3:0][Rdy]</a> .    |
| 0    | Reserved.                                                                                                                       |

#### **D18F2x9C\_x0002\_000B\_dct[3:0] Power State Command**

Cold reset: 0000\_0002h.

| Bits  | Description                                                                                                                                                                                                                                                                                                              |      |             |     |                      |     |                 |     |             |     |                                   |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|-----|----------------------|-----|-----------------|-----|-------------|-----|-----------------------------------|
| 31:16 | Reserved.                                                                                                                                                                                                                                                                                                                |      |             |     |                      |     |                 |     |             |     |                                   |
| 15:14 | <b>CmdType: Command Type.</b> Read-write.<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>Change to PS0 or PS1</td></tr> <tr> <td>01b</td><td>NbPstate Update</td></tr> <tr> <td>10b</td><td>Phase Align</td></tr> <tr> <td>11b</td><td>Null, update register values only</td></tr> </table> | Bits | Description | 00b | Change to PS0 or PS1 | 01b | NbPstate Update | 10b | Phase Align | 11b | Null, update register values only |
| Bits  | Description                                                                                                                                                                                                                                                                                                              |      |             |     |                      |     |                 |     |             |     |                                   |
| 00b   | Change to PS0 or PS1                                                                                                                                                                                                                                                                                                     |      |             |     |                      |     |                 |     |             |     |                                   |
| 01b   | NbPstate Update                                                                                                                                                                                                                                                                                                          |      |             |     |                      |     |                 |     |             |     |                                   |
| 10b   | Phase Align                                                                                                                                                                                                                                                                                                              |      |             |     |                      |     |                 |     |             |     |                                   |
| 11b   | Null, update register values only                                                                                                                                                                                                                                                                                        |      |             |     |                      |     |                 |     |             |     |                                   |
| 13:10 | Reserved.                                                                                                                                                                                                                                                                                                                |      |             |     |                      |     |                 |     |             |     |                                   |
| 9:8   | <b>NbPstate: Nb Pstate.</b> Read-write.                                                                                                                                                                                                                                                                                  |      |             |     |                      |     |                 |     |             |     |                                   |
| 7:5   | Reserved.                                                                                                                                                                                                                                                                                                                |      |             |     |                      |     |                 |     |             |     |                                   |
| 4     | <b>EnterS3: Enter S3.</b> Read-write. 1= PHY removes the MemReset control from DCT interface in preparation of S3 state transition. Only valid with LP2 command.                                                                                                                                                         |      |             |     |                      |     |                 |     |             |     |                                   |

| 3         | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                |      |             |      |     |      |     |           |          |      |     |           |          |
|-----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|------|-----|------|-----|-----------|----------|------|-----|-----------|----------|
| 2:0       | <b>PhyPowerState: Phy Power State.</b> Read-write. Specifies the phy power state to transition to when this register is written.<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>000b</td><td>PS0</td></tr> <tr> <td>001b</td><td>PS1</td></tr> <tr> <td>011b-010b</td><td>Reserved</td></tr> <tr> <td>100b</td><td>LP2</td></tr> <tr> <td>111b-101b</td><td>Reserved</td></tr> </table> | Bits | Description | 000b | PS0 | 001b | PS1 | 011b-010b | Reserved | 100b | LP2 | 111b-101b | Reserved |
| Bits      | Description                                                                                                                                                                                                                                                                                                                                                                                              |      |             |      |     |      |     |           |          |      |     |           |          |
| 000b      | PS0                                                                                                                                                                                                                                                                                                                                                                                                      |      |             |      |     |      |     |           |          |      |     |           |          |
| 001b      | PS1                                                                                                                                                                                                                                                                                                                                                                                                      |      |             |      |     |      |     |           |          |      |     |           |          |
| 011b-010b | Reserved                                                                                                                                                                                                                                                                                                                                                                                                 |      |             |      |     |      |     |           |          |      |     |           |          |
| 100b      | LP2                                                                                                                                                                                                                                                                                                                                                                                                      |      |             |      |     |      |     |           |          |      |     |           |          |
| 111b-101b | Reserved                                                                                                                                                                                                                                                                                                                                                                                                 |      |             |      |     |      |     |           |          |      |     |           |          |

#### **D18F2x9C\_x0002\_000E\_dct[3:0] Global Control**

Cold reset: 0000\_0003h.

| Bits | Description                                                                                                                                                                                                                                                                                             |
|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:2 | Reserved.                                                                                                                                                                                                                                                                                               |
| 1    | <b>PhyDisable: Phy Disable.</b> Read-write. BIOS: 2.9.9.2. 1=Phy is disabled. 0=Phy is enabled.                                                                                                                                                                                                         |
| 0    | <b>G5_Mode: GDDR5 Mode.</b> Read-write. 1=Combo phy master chip is in GDDR5 mode. 0=Combo phy master chip is in DDR3 mode. The phy writes this value to all slave chiplet instances during a configuration write to <a href="#">D18F2x9C_x0002_000B_dct[3:0]</a> . See section 2.9 for product support. |

#### **D18F2x9C\_x00F2\_0015\_dct[3:0] Vref Byte**

Cold reset: 0000\_0000h.

| Bits | Description                                                                                                                           |
|------|---------------------------------------------------------------------------------------------------------------------------------------|
| 31:4 | Reserved.                                                                                                                             |
| 3:0  | <b>VrefFilt: Vref filter.</b> Read-write. BIOS: 0h. This field adjusts noise coupling on to VrefOut and adjusts the input resistance. |

#### **D18F2x9C\_x0002\_0032\_dct[3:0] US Mailbox 1 Message**

Cold reset: 0000\_0000h.

| Bits  | Description                                                                             |
|-------|-----------------------------------------------------------------------------------------|
| 31:16 | Reserved.                                                                               |
| 15:0  | <b>Message: Message.</b> Read-write. This field specifies the encoded message received. |

#### **D18F2x9C\_x0002\_0033\_dct[3:0] US Mailbox 1 Protocol**

Cold reset: 0000\_0001h.

| Bits | Description                                                                                                                                                                                                                                                             |
|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:1 | Reserved.                                                                                                                                                                                                                                                               |
| 0    | <b>Rdy: Ready.</b> Read-write. 1=The US Mailbox 1 is ready for a data transfer from the PMU to the mailbox; the PMU may write to <a href="#">D18F2x9C_x0002_0032_dct[3:0]</a> [Message]. 0=PMU may not write to <a href="#">D18F2x9C_x0002_0032_dct[3:0]</a> [Message]. |



**D18F2x9C\_x0002\_0034\_dct[3:0] US Mailbox 2 Message**

Cold reset: 0000\_0000h.

| Bits  | Description                                                                  |
|-------|------------------------------------------------------------------------------|
| 31:16 | Reserved.                                                                    |
| 15:0  | <b>Message: Message.</b> Read-write. This field specifies the data received. |

**D18F2x9C\_x0002\_0035\_dct[3:0] US Mailbox 2 Protocol**

Cold reset: 0000\_0001h.

| Bits | Description                                                                                                                                                                                                                                                             |
|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:1 | Reserved.                                                                                                                                                                                                                                                               |
| 0    | <b>Rdy: Ready.</b> Read-write. 1=The US Mailbox 2 is ready for a data transfer from the PMU to the mailbox; the PMU may write to <a href="#">D18F2x9C_x0002_0034_dct[3:0][Message]</a> . 0=PMU may not write to <a href="#">D18F2x9C_x0002_0034_dct[3:0][Message]</a> . |

**D18F2x9C\_x0002\_005B\_dct[3:0] D3\_EVTMERR**

Cold reset: 0000\_003Fh.

| Bits | Description                                                                                          |
|------|------------------------------------------------------------------------------------------------------|
| 31:4 | Reserved.                                                                                            |
| 3    | <b>D3MERR_RxEn: MEMERR receiver enable.</b> Read-write. BIOS:0. 1=Enable receiver for MEMERR pad.    |
| 2:1  | Reserved.                                                                                            |
| 0    | <b>D3EVNT_RxEn: EVENT_L receiver enable.</b> Read-write. BIOS: 1. 1=Enable receiver for EVENT_L pad. |

**D18F2x9C\_x0002\_005F\_dct[3:0] Misc Phy Status**

Cold reset: 0000\_000xh.

| Bits | Description                                                                                                                                                                                                                                                                                                                                                              |
|------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:2 | Reserved.                                                                                                                                                                                                                                                                                                                                                                |
| 1    | <b>PORMemReset: POR MemReset.</b> Read-only. 1=Previous cold reset was a power-up event (accompanied by ramping VDDIO). 0=Previous cold reset was associated with S3 (VDDIO was already supplied).                                                                                                                                                                       |
| 0    | <b>DctSane: Dct Sane.</b> Read-only; updated-by-hardware. 1=Software provides the logic state of Memreset_L to drive as specified by <a href="#">D18F2x9C_x0002_0060_dct[3:0][MemReset]</a> . 0=MemReset_L logic state is provided by the complement of PORMemReset. This bit is set by hardware after the first write to <a href="#">D18F2x9C_x0002_000B_dct[3:0]</a> . |

**D18F2x9C\_x0002\_0060\_dct[3:0] Memreset Control**

Cold reset: 0000\_0000h.

| Bits | Description                                                                                                                                                                                                                                            |
|------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:1 | Reserved.                                                                                                                                                                                                                                              |
| 0    | <b>MemReset_L</b> . Read-write. BIOS: See 2.9.9.5. 1=MemReset_L pin is driven inactive when <a href="#">D18F2x9C_x0002_005F_dct[3:0][DctSane]=1</a> . 0=MemReset_L pin is driven active when <a href="#">D18F2x9C_x0002_005F_dct[3:0][DctSane]=1</a> . |

#### **D18F2x9C\_x0[1:0]02\_0080\_dct[3:0] PMU CLK Divider**

Cold reset: 0000\_0008h.

Table 179: [Index Mapping](#) for [D18F2x9C\\_x0\[1:0\]02\\_0080\\_dct\[3:0\]](#)

| Address Bits                             | Valid Values | Name            |
|------------------------------------------|--------------|-----------------|
| <a href="#">D18F2x98_dct[3:0][27:24]</a> | 0h           | memory Pstate 0 |
| <a href="#">D18F2x98_dct[3:0][27:24]</a> | 1h           | memory Pstate 1 |

| Bits        | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |      |             |       |             |       |             |       |             |       |             |       |             |       |              |       |                    |             |                      |
|-------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|-------|-------------|-------|-------------|-------|-------------|-------|-------------|-------|-------------|-------|--------------|-------|--------------------|-------------|----------------------|
| 31:4        | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |      |             |       |             |       |             |       |             |       |             |       |             |       |              |       |                    |             |                      |
| 3:0         | <p><b>PMUClkDiv: PMU CLK divider.</b> Read-write. BIOS: <a href="#">2.9.9.2.3</a>. Specifies the divider from PCLK to the PMU input clock. PCLK frequency is the same as the data rate (See <a href="#">D18F2x9C_x0002_0000_dct[3:0][PllMultDiv]</a> and <a href="#">D18F2x9C_x0002_0001_dct[3:0][PllMultDiv]</a>). This must be programmed so the PMU operates no faster than 533 MHz. Software should program this to the smallest divider which meets this condition for best training results. For example, if the data rate is 5Gb/s (PllMultDiv=3200h) then PMUClkDiv=divide by 10 (the PMU runs at 500 MHz). If for example, the data rate is 667Mb/s (PllMultDiv=0603h) then PMUClkDiv=divide by 2 (the PMU runs at 333 MHz). When training is complete and the PMU is in reset, it is recommended that BIOS program this to PMU CLK = CPU RefClk.</p> <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>0000b</td><td>divide by 1</td></tr> <tr> <td>0001b</td><td>divide by 2</td></tr> <tr> <td>0010b</td><td>divide by 4</td></tr> <tr> <td>0011b</td><td>divide by 6</td></tr> <tr> <td>0100b</td><td>divide by 8</td></tr> <tr> <td>0101b</td><td>divide by 10</td></tr> <tr> <td>0111b</td><td>PMU CLK turned off</td></tr> <tr> <td>1111b-1000b</td><td>PMU CLK = CPU Refclk</td></tr> </table> | Bits | Description | 0000b | divide by 1 | 0001b | divide by 2 | 0010b | divide by 4 | 0011b | divide by 6 | 0100b | divide by 8 | 0101b | divide by 10 | 0111b | PMU CLK turned off | 1111b-1000b | PMU CLK = CPU Refclk |
| Bits        | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |      |             |       |             |       |             |       |             |       |             |       |             |       |              |       |                    |             |                      |
| 0000b       | divide by 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |      |             |       |             |       |             |       |             |       |             |       |             |       |              |       |                    |             |                      |
| 0001b       | divide by 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |      |             |       |             |       |             |       |             |       |             |       |             |       |              |       |                    |             |                      |
| 0010b       | divide by 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |      |             |       |             |       |             |       |             |       |             |       |             |       |              |       |                    |             |                      |
| 0011b       | divide by 6                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |      |             |       |             |       |             |       |             |       |             |       |             |       |              |       |                    |             |                      |
| 0100b       | divide by 8                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |      |             |       |             |       |             |       |             |       |             |       |             |       |              |       |                    |             |                      |
| 0101b       | divide by 10                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |      |             |       |             |       |             |       |             |       |             |       |             |       |              |       |                    |             |                      |
| 0111b       | PMU CLK turned off                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |      |             |       |             |       |             |       |             |       |             |       |             |       |              |       |                    |             |                      |
| 1111b-1000b | PMU CLK = CPU Refclk                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |      |             |       |             |       |             |       |             |       |             |       |             |       |              |       |                    |             |                      |

#### **D18F2x9C\_x0002\_0087\_dct[3:0] Disable Calibration**

Cold reset: 0000\_0014h.

| Bits | Description |
|------|-------------|
| 31:2 | Reserved.   |

|   |                                                                                                                                                                                                                                                                                                                                                                        |
|---|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | <b>DisAutoComp: Disable automatic compensation.</b> Read-write. BIOS: <a href="#">2.9.9.2.5</a> . 1=Disable automatic updates of Tx and POdt targets. If <a href="#">Ddr3Mode</a> each 64-bit channel has one calibrator and one disable bit. If <a href="#">Gddr5Mode</a> two 32-bit channels have one calibrator and one disable bit located in the master channel.  |
| 0 | <b>DisPredriverCal: Disable predriver calibration.</b> Read-write. BIOS: <a href="#">2.9.9.2.5</a> . 1=Disable automatic updates of predriver targets. If <a href="#">Ddr3Mode</a> each 64-bit channel has one calibrator and one disable bit. If <a href="#">Gddr5Mode</a> two 32-bit channels have one calibrator and one disable bit located in the master channel. |

**D18F2x9C\_x0002\_0088\_dct[3:0] CalRate**

Cold reset: 0000\_0083h.

| Bits | Description                                                                                                                 |
|------|-----------------------------------------------------------------------------------------------------------------------------|
| 31:9 | Reserved.                                                                                                                   |
| 8    | <b>CalOdtNeverLock: Calibration init Odt no-lock mode.</b> Read-write. BIOS: <a href="#">2.9.9.2.5</a> .                    |
| 7    | <b>CalInitMode: Calibration init mode.</b> Read-write. BIOS: <a href="#">2.9.9.2.5</a> .                                    |
| 6    | Reserved.                                                                                                                   |
| 5    | <b>CalOnce: Calibration run one time.</b> Read-write. BIOS: <a href="#">2.9.9.2.5</a> . 1=Run one time. 0=Run continuously. |
| 4    | <b>CalRun: Calibration run.</b> Read-write. BIOS: <a href="#">2.9.9.2.5</a> .                                               |
| 3:0  | <b>CalInterval: Calibration interval.</b> Read-write. BIOS: <a href="#">2.9.9.2.5</a> .                                     |

**D18F2x9C\_x0002\_0089\_dct[3:0] PllLockTime**

Cold reset: 0000\_00C8h.

| Bits  | Description                                                                                                                                                                    |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:16 | Reserved.                                                                                                                                                                      |
| 15:0  | <b>PllLockTime: Pll lock time.</b> Read-write. BIOS: <a href="#">2.9.9.2.3</a> . Specifies the number of 5ns periods the phy waits for PLLs to lock during a frequency change. |

**D18F2x9C\_x0002\_0093\_dct[3:0] PllRegWaitTime**

Cold reset: 0000\_0023h.

| Bits  | Description                                                                                                                                                                                                                         |
|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:16 | Reserved.                                                                                                                                                                                                                           |
| 15:0  | <b>PllRegWaitTime: PLL regulator wait time.</b> Read-write. BIOS: <a href="#">2.9.9.2.3</a> . Specifies the number of 5 ns periods the phy waits for the PLL to become stable when coming out of PLL regulator off power down mode. |

**D18F2x9C\_x0002\_0097\_dct[3:0] CalBusy**

Cold reset: 0000\_0000h.

| Bits | Description                                  |
|------|----------------------------------------------|
| 31:1 | Reserved.                                    |
| 0    | <b>CalBusy: Calibration busy.</b> Read-only. |

**D18F2x9C\_x0002\_0098\_dct[3:0] Cal Misc 2**

Cold reset: 0000\_0204h.

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                          |      |                   |     |       |     |       |     |       |     |          |
|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------------|-----|-------|-----|-------|-----|-------|-----|----------|
| 31:14 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                            |      |                   |     |       |     |       |     |       |     |          |
| 13    | <b>CalG5D3: Calibrate G5 D3.</b> Read-write. BIOS: (D18F2x9C_x00[F,3:0]0_[F,B:0]04A_dct[3:0][MajorMode[0]]). 1=Calibrator performs the GDDR5 sequence. 0=Calibrator performs the DDR3 sequence. See section 2.9 for product support.                                                                                                                                                                                 |      |                   |     |       |     |       |     |       |     |          |
| 12:11 | <b>CalCmptrResTrim: Calibration comparator resistance trim.</b> Read-write. BIOS: 2.9.9.2.2. Specifies input comparator voltage. This should be programmed consistent with I/O voltage.<br><table> <tr> <th>Bits</th><th>Cal Cmptr voltage</th></tr> <tr> <td>00b</td><td>1.50V</td></tr> <tr> <td>01b</td><td>1.35V</td></tr> <tr> <td>10b</td><td>1.25V</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table> | Bits | Cal Cmptr voltage | 00b | 1.50V | 01b | 1.35V | 10b | 1.25V | 11b | Reserved |
| Bits  | Cal Cmptr voltage                                                                                                                                                                                                                                                                                                                                                                                                    |      |                   |     |       |     |       |     |       |     |          |
| 00b   | 1.50V                                                                                                                                                                                                                                                                                                                                                                                                                |      |                   |     |       |     |       |     |       |     |          |
| 01b   | 1.35V                                                                                                                                                                                                                                                                                                                                                                                                                |      |                   |     |       |     |       |     |       |     |          |
| 10b   | 1.25V                                                                                                                                                                                                                                                                                                                                                                                                                |      |                   |     |       |     |       |     |       |     |          |
| 11b   | Reserved                                                                                                                                                                                                                                                                                                                                                                                                             |      |                   |     |       |     |       |     |       |     |          |
| 10:0  | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                            |      |                   |     |       |     |       |     |       |     |          |

#### D18F2x9C\_x0002\_0099\_dct[3:0] PMU Reset

Cold reset: 0000\_0001h.

| Bits | Description                                                                                                                                                                                           |
|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:7 | Reserved.                                                                                                                                                                                             |
| 6    | <b>SRAM_SD: PMU SRAM Shutdown.</b> Read-write. BIOS: 2.9.9.9. 1=Power down PMU SRAM.                                                                                                                  |
| 5:4  | Reserved.                                                                                                                                                                                             |
| 3    | <b>PmuReset: PMU Reset.</b> Read-write. BIOS: 2.9.9.2. 1=Places the phy microcontroller unit (PMU) in reset. 0=Starts clocks and removes the reset signal to the PMU.                                 |
| 2:1  | Reserved.                                                                                                                                                                                             |
| 0    | <b>PmuStall: PMU Stall.</b> Read-write. BIOS: 2.9.9.2. 1=Places the phy microcontroller unit (PMU) in a clock gated stall state. 0=Starts clocks and resume execution at current instruction pointer. |

#### D18F2x[B,0]9C\_x0005\_[5BFF:4000]\_dct[3:0] PMU IC SRAM

Cold reset: 0000\_0000h.

This is a word-addressable address space.

Software must write a pair of words into PMU SRAM, starting with an numbered index, in order for a write to be properly latched. E.g. writing to SRAM index 0 and then index 1 will result in two data words being written to SRAM; writing to index 0 only or index 1 only will result in no data being written to SRAM. If writing an even numbered word-sized block of SRAM then no additional writes are necessary. If writing with random access and software loses track of how many words were written, then it should assume the write was not latched and re-write utilizing a pair of accesses as stated above. It is not recommended to interrupt two consecutive writes with an intervening read operation.

| Bits  | Description                                                             |
|-------|-------------------------------------------------------------------------|
| 31:16 | Reserved.                                                               |
| 15:0  | <b>PMUFirmwareSRAM: PMU Firmware SRAM.</b> Read-write. BIOS: 2.9.9.2.9. |

**D18F2x9C\_x0005\_[0BFF:0000]\_dct[3:0] PMU SRAM Message Block**

Cold reset: 0000\_0000h.

This is a word-addressable address space. The lower 256 bytes of SRAM in the data portion of the address map is the SRAMMsgBlk. The remaining portion of the 6KB of SRAM is used by the system.

Software must write a pair of words into PMU SRAM, starting with an even numbered index, in order for a write to be properly latched. E.g. writing to SRAM index 0 and then index 1 will result in two data words being written to SRAM; writing to only an even index will result in no data written to SRAM; writing to only an odd index will result in arbitrary data written to the memory addressed by the corresponding even index (destroying the prior contents) but the odd index will be written with the intended data. If writing an even numbered word-sized block of SRAM aligned on an even index then no additional writes are necessary. If writing with random access and software loses track of how many words were written, then it should assume the write was not latched and re-write utilizing a pair of accesses as stated above. It is not recommended to interrupt two consecutive writes with an intervening read operation.

| Bits  | Description                                                                  |
|-------|------------------------------------------------------------------------------|
| 31:16 | Reserved.                                                                    |
| 15:0  | <b>SRAMMsgBlk: SRAMMsgBlk.</b> Read-write. BIOS: <a href="#">2.9.9.2.9</a> . |

**D18F2x9C\_x00F4\_00E[7:0]\_dct[3:0] Odt Pattern**

Cold reset: 0000\_0000h.

| Bits | Description                                                                                                                                                                                                                                                                                                        |
|------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:8 | Reserved.                                                                                                                                                                                                                                                                                                          |
| 7:4  | <b>OdtRdPatCs: Odt read pattern Cs[7:0].</b> Read-write. BIOS: See <a href="#">D18F2x[234:230]_dct[3:0]</a> . This register specifies the ODT[3:0] pin pattern during a read to chipselect [7:0]. It is used by the PMU during initial training for DDR3 mode and does not need to be saved and restored for S3.   |
| 3:0  | <b>OdtWrPatCs: Odt write pattern Cs[7:0].</b> Read-write. BIOS: See <a href="#">D18F2x[23C:238]_dct[3:0]</a> . This register specifies the ODT[3:0] pin pattern during a write to chipselect [7:0]. It is used by the PMU during initial training for DDR3 mode and does not need to be saved and restored for S3. |

**D18F2x9C\_x00F4\_00FD\_dct[3:0] Phy CKE control**

Cold reset: 0000\_0000h.

| Bits | Description                                                                                                                                                                                                                                                     |
|------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:8 | Reserved.                                                                                                                                                                                                                                                       |
| 7:4  | <b>AcsmCkeEnb[3:0]: ACSM CKE enable[3:0].</b> Read-write. 1=If AcsmCkeOride=1 then CKE is asserted active. 0=If AcsmCkeOride=1 then CKE is deasserted.                                                                                                          |
| 3:0  | <b>AcsmCkeOride[3:0]: ACSM CKE override[3:0].</b> Read-write. 1=When the DCT is not connected, PMU overrides the ACSM output values, allowing directly programmability with AcsmCkeEnb. 0=When the DCT is not connected, the ACSM determines CKE output values. |

**D18F2x9C\_x0007\_0015\_dct[3:0] Lane to CRC Map0**

Cold reset: 0000\_0000h.

| Bits  | Description                                                              |
|-------|--------------------------------------------------------------------------|
| 31:12 | Reserved.                                                                |
| 11:9  | <b>CrcLaneMap3: Crc lane map 3.</b> Read-write. Map lane 3 to CRC input. |
| 8:6   | <b>CrcLaneMap2: Crc lane map 2.</b> Read-write. Map lane 2 to CRC input. |
| 5:3   | <b>CrcLaneMap1: Crc lane map 1.</b> Read-write. Map lane 1 to CRC input. |
| 2:0   | <b>CrcLaneMap0: Crc lane map 0.</b> Read-write. Map lane 0 to CRC input. |

#### **D18F2x9C\_x0007\_0016\_dct[3:0] Lane to CRC Map1**

Cold reset: 0000\_0000h.

| Bits  | Description                                                              |
|-------|--------------------------------------------------------------------------|
| 31:12 | Reserved.                                                                |
| 11:9  | <b>CrcLaneMap7: Crc lane map 7.</b> Read-write. Map lane 7 to CRC input. |
| 8:6   | <b>CrcLaneMap6: Crc lane map 6.</b> Read-write. Map lane 6 to CRC input. |
| 5:3   | <b>CrcLaneMap5: Crc lane map 5.</b> Read-write. Map lane 5 to CRC input. |
| 2:0   | <b>CrcLaneMap4: Crc lane map 4.</b> Read-write. Map lane 4 to CRC input. |

#### **D18F2x9C\_x0009\_0000\_dct[3:0] ABIT Enable**

Cold reset: 0000\_0000h.

| Bits | Description                                                                                                                                                                                                                                                                                           |
|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:1 | Reserved.                                                                                                                                                                                                                                                                                             |
| 0    | <b>ABitEn: ABIT enable.</b> Read-write. 1=ABIT chiplet is enabled. The ABIT chiplet is used to extend the number of address/command bits controlled by the phy while having separate granular control from existing ABYTE chips. 0=ABIT chiplet is powered down. Chip still responds to CSR accesses. |

#### **D18F2x9C\_x0009\_000E\_dct[3:0] Global Control Slave**

Cold reset: 0000\_0001h.

| Bits | Description                                                                                                                                                   |
|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:1 | Reserved.                                                                                                                                                     |
| 0    | <b>G5_Mode: GDDR5 Mode.</b> Read-write. 1=Combo phy slave chip is in GDDR5 mode. 0=Combo phy slave chip is in DDR3 mode. See section 2.9 for product support. |

#### **D18F2x9C\_x0009\_004A\_dct[3:0] Rx Control 1**

Cold reset: 0000\_0080h. See 2.9.4.1 for chiplet to pad and 2.9.4 for pad to pin mapping.

D18F2x98\_dct[3:0][15:12] selects the pad number.

| Bits | Description                                                   |
|------|---------------------------------------------------------------|
| 31:9 | Reserved.                                                     |
| 8    | <b>BiasBypassEn: Bias bypass enable.</b> Read-write. BIOS: 0. |

| 7           | <b>PowerDownRcvr: Power down receiver.</b> Read-write. BIOS: See <a href="#">2.9.9.9</a> . 1=Power down the receiver.                                                                                                                                                                     |             |                    |      |      |           |          |
|-------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|--------------------|------|------|-----------|----------|
| 6:4         | <b>MajorMode: Major mode.</b> Read-write. BIOS: See <a href="#">2.9.9.2</a> . Specifies operating mode of the phy logic.<br><table> <tr> <th><u>Bits</u></th><th><u>Description</u></th></tr> <tr> <td>000b</td><td>DDR3</td></tr> <tr> <td>111b-001b</td><td>Reserved</td></tr> </table> | <u>Bits</u> | <u>Description</u> | 000b | DDR3 | 111b-001b | Reserved |
| <u>Bits</u> | <u>Description</u>                                                                                                                                                                                                                                                                        |             |                    |      |      |           |          |
| 000b        | DDR3                                                                                                                                                                                                                                                                                      |             |                    |      |      |           |          |
| 111b-001b   | Reserved                                                                                                                                                                                                                                                                                  |             |                    |      |      |           |          |
| 3:0         | Reserved.                                                                                                                                                                                                                                                                                 |             |                    |      |      |           |          |

#### **D18F2x9C\_x00FF\_000D\_dct[3:0] Phy Clock Control**

Cold reset: 0000\_0000h.

| Bits | Description                                                                                                                                                                                                                                                                    |
|------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:1 | Reserved.                                                                                                                                                                                                                                                                      |
| 0    | <b>PhyClkCtl: Phy Clock Control.</b> Read-write. BIOS: See <a href="#">2.9.9.7</a> . 1=Do not stop bus clocks when control is handed off between the DCT and the PMU. This is used to pass from normal operating mode to periodic phase training without glitching bus clocks. |



**D18F2xA4 DRAM Controller Temperature Throttle**

See 2.9.3 [DCT Configuration Registers].

See 2.9.14 [DRAM On DIMM Thermal Management and Power Capping].

| Bits        | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |             |                    |       |                                |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |          |       |                                                   |       |          |
|-------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|--------------------|-------|--------------------------------|-------|--------------------------|-------|--------------------------|-------|--------------------------|-------|--------------------------|-------|--------------------------|-------|--------------------------|-------|--------------------------|-------|--------------------------|-------|--------------------------|-------|--------------------------|-------|--------------------------|-------|--------------------------|-------|----------|-------|---------------------------------------------------|-------|----------|
| 31:24       | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |             |                    |       |                                |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |          |       |                                                   |       |          |
| 23:20       | <p><b>BwCapCmdThrottleMode: bandwidth capping command throttle mode.</b> Read-write. Reset: 0. Specifies the command throttle mode when BwCapEn=1. The DCT throttles commands over a rolling window of 100 clock cycles, maintaining the average throttling as specified by this field.</p> <table> <tr> <th><u>Bits</u></th><th><u>Description</u></th></tr> <tr><td>0000b</td><td>Command throttling is disabled</td></tr> <tr><td>0001b</td><td>Throttle commands by 30%</td></tr> <tr><td>0010b</td><td>Throttle commands by 40%</td></tr> <tr><td>0011b</td><td>Throttle commands by 50%</td></tr> <tr><td>0100b</td><td>Throttle commands by 55%</td></tr> <tr><td>0101b</td><td>Throttle commands by 60%</td></tr> <tr><td>0110b</td><td>Throttle commands by 65%</td></tr> <tr><td>0111b</td><td>Throttle commands by 70%</td></tr> <tr><td>1000b</td><td>Throttle commands by 75%</td></tr> <tr><td>1001b</td><td>Throttle commands by 80%</td></tr> <tr><td>1010b</td><td>Throttle commands by 85%</td></tr> <tr><td>1011b</td><td>Throttle commands by 90%</td></tr> <tr><td>1100b</td><td>Throttle commands by 95%</td></tr> <tr><td>1101b</td><td>Reserved</td></tr> <tr><td>1110b</td><td>Throttle commands as specified by CmdThrottleMode</td></tr> <tr><td>1111b</td><td>Reserved</td></tr> </table> <p>Throttling should not be enabled until after DRAM initialization (D18F2x110[DramEnable]=1) and training (see 2.9.9.6 [DRAM Training]) are complete.</p> | <u>Bits</u> | <u>Description</u> | 0000b | Command throttling is disabled | 0001b | Throttle commands by 30% | 0010b | Throttle commands by 40% | 0011b | Throttle commands by 50% | 0100b | Throttle commands by 55% | 0101b | Throttle commands by 60% | 0110b | Throttle commands by 65% | 0111b | Throttle commands by 70% | 1000b | Throttle commands by 75% | 1001b | Throttle commands by 80% | 1010b | Throttle commands by 85% | 1011b | Throttle commands by 90% | 1100b | Throttle commands by 95% | 1101b | Reserved | 1110b | Throttle commands as specified by CmdThrottleMode | 1111b | Reserved |
| <u>Bits</u> | <u>Description</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |             |                    |       |                                |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |          |       |                                                   |       |          |
| 0000b       | Command throttling is disabled                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |             |                    |       |                                |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |          |       |                                                   |       |          |
| 0001b       | Throttle commands by 30%                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |             |                    |       |                                |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |          |       |                                                   |       |          |
| 0010b       | Throttle commands by 40%                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |             |                    |       |                                |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |          |       |                                                   |       |          |
| 0011b       | Throttle commands by 50%                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |             |                    |       |                                |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |          |       |                                                   |       |          |
| 0100b       | Throttle commands by 55%                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |             |                    |       |                                |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |          |       |                                                   |       |          |
| 0101b       | Throttle commands by 60%                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |             |                    |       |                                |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |          |       |                                                   |       |          |
| 0110b       | Throttle commands by 65%                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |             |                    |       |                                |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |          |       |                                                   |       |          |
| 0111b       | Throttle commands by 70%                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |             |                    |       |                                |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |          |       |                                                   |       |          |
| 1000b       | Throttle commands by 75%                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |             |                    |       |                                |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |          |       |                                                   |       |          |
| 1001b       | Throttle commands by 80%                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |             |                    |       |                                |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |          |       |                                                   |       |          |
| 1010b       | Throttle commands by 85%                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |             |                    |       |                                |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |          |       |                                                   |       |          |
| 1011b       | Throttle commands by 90%                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |             |                    |       |                                |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |          |       |                                                   |       |          |
| 1100b       | Throttle commands by 95%                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |             |                    |       |                                |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |          |       |                                                   |       |          |
| 1101b       | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |             |                    |       |                                |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |          |       |                                                   |       |          |
| 1110b       | Throttle commands as specified by CmdThrottleMode                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |             |                    |       |                                |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |          |       |                                                   |       |          |
| 1111b       | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |             |                    |       |                                |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |          |       |                                                   |       |          |
| 19:16       | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |             |                    |       |                                |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |          |       |                                                   |       |          |
| 15          | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |             |                    |       |                                |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |                          |       |          |       |                                                   |       |          |

| 14:12 | <p><b>CmdThrottleMode: command throttle mode.</b> Read-write. Reset: 0. BIOS: See <a href="#">2.9.9.6 [DRAM Training]</a>. Specifies the command throttle mode when ODTSEn=1 and the EVENT_L pin is asserted. The DCT throttles commands over a rolling window of 100 clock cycles, maintaining the average throttling as specified by this field.</p> <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>000b</td><td>Command throttling is disabled.</td></tr> <tr> <td>001b</td><td>Throttle commands by 30%.</td></tr> <tr> <td>010b</td><td>Throttle commands by 50%.</td></tr> <tr> <td>011b</td><td>Throttle commands by 60%.</td></tr> <tr> <td>100b</td><td>Throttle commands by 70%.</td></tr> <tr> <td>101b</td><td>Throttle commands by 80%.</td></tr> <tr> <td>110b</td><td>Throttle commands by 90%.</td></tr> <tr> <td>111b</td><td>Place the DRAM devices in powerdown mode (see <a href="#">D18F2x94_dct[3:0][PowerDownMode]</a>) when EVENT_L is asserted. This mode is not valid if <a href="#">D18F2x94_dct[3:0][PowerDownEn]</a>=0.</td></tr> </table> <p>Throttling should not be enabled until after DRAM initialization (<a href="#">D18F2x110[DrainEnable]</a>=1) and training are complete. See also <a href="#">BwCapEn</a>.</p> | Bits | Description | 000b | Command throttling is disabled. | 001b | Throttle commands by 30%. | 010b | Throttle commands by 50%. | 011b | Throttle commands by 60%. | 100b | Throttle commands by 70%. | 101b | Throttle commands by 80%. | 110b | Throttle commands by 90%. | 111b | Place the DRAM devices in powerdown mode (see <a href="#">D18F2x94_dct[3:0][PowerDownMode]</a> ) when EVENT_L is asserted. This mode is not valid if <a href="#">D18F2x94_dct[3:0][PowerDownEn]</a> =0. |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|------|---------------------------------|------|---------------------------|------|---------------------------|------|---------------------------|------|---------------------------|------|---------------------------|------|---------------------------|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |      |             |      |                                 |      |                           |      |                           |      |                           |      |                           |      |                           |      |                           |      |                                                                                                                                                                                                         |
| 000b  | Command throttling is disabled.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |      |             |      |                                 |      |                           |      |                           |      |                           |      |                           |      |                           |      |                           |      |                                                                                                                                                                                                         |
| 001b  | Throttle commands by 30%.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |      |             |      |                                 |      |                           |      |                           |      |                           |      |                           |      |                           |      |                           |      |                                                                                                                                                                                                         |
| 010b  | Throttle commands by 50%.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |      |             |      |                                 |      |                           |      |                           |      |                           |      |                           |      |                           |      |                           |      |                                                                                                                                                                                                         |
| 011b  | Throttle commands by 60%.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |      |             |      |                                 |      |                           |      |                           |      |                           |      |                           |      |                           |      |                           |      |                                                                                                                                                                                                         |
| 100b  | Throttle commands by 70%.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |      |             |      |                                 |      |                           |      |                           |      |                           |      |                           |      |                           |      |                           |      |                                                                                                                                                                                                         |
| 101b  | Throttle commands by 80%.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |      |             |      |                                 |      |                           |      |                           |      |                           |      |                           |      |                           |      |                           |      |                                                                                                                                                                                                         |
| 110b  | Throttle commands by 90%.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |      |             |      |                                 |      |                           |      |                           |      |                           |      |                           |      |                           |      |                           |      |                                                                                                                                                                                                         |
| 111b  | Place the DRAM devices in powerdown mode (see <a href="#">D18F2x94_dct[3:0][PowerDownMode]</a> ) when EVENT_L is asserted. This mode is not valid if <a href="#">D18F2x94_dct[3:0][PowerDownEn]</a> =0.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |      |             |      |                                 |      |                           |      |                           |      |                           |      |                           |      |                           |      |                           |      |                                                                                                                                                                                                         |
| 11    | <p><b>BwCapEn: bandwidth capping enable.</b> Read-write. Reset: 0. 1=The memory command throttle mode specified by <a href="#">BwCapCmdThrottleMode</a> is applied.</p> <p>This bit is used by software to enable command throttling independent of the state of the EVENT_L pin. If this bit is set, ODTSEn=1, and the EVENT_L pin is asserted, the larger of the two throttle percentages specified by <a href="#">CmdThrottleMode</a> and <a href="#">BwCapCmdThrottleMode</a> is used.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |      |             |      |                                 |      |                           |      |                           |      |                           |      |                           |      |                           |      |                           |      |                                                                                                                                                                                                         |
| 10:9  | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |      |             |      |                                 |      |                           |      |                           |      |                           |      |                           |      |                           |      |                           |      |                                                                                                                                                                                                         |
| 8     | <p><b>ODTSEn: on DIMM temperature sensor enable.</b> Read-write. Reset: 0.</p> <p>BIOS: See <a href="#">2.9.9.6 [DRAM Training]</a>.</p> <p>Enables the monitoring of the EVENT_L pin and indicates whether the on DIMM temperature sensors of the DIMMs on a channel are enabled. 0=Disabled. 1=Enabled. While the EVENT_L pin is asserted, the controller (a) doubles the refresh rate (if <math>T_{ref}=7.8\text{ us}</math>), and (b) throttles the address bus utilization as specified by <a href="#">CmdThrottleMode[2:0]</a>.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |      |             |      |                                 |      |                           |      |                           |      |                           |      |                           |      |                           |      |                           |      |                                                                                                                                                                                                         |
| 7:0   | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |      |             |      |                                 |      |                           |      |                           |      |                           |      |                           |      |                           |      |                           |      |                                                                                                                                                                                                         |

## D18F2xA8\_dct[3:0] DRAM Controller Miscellaneous 2

See [2.9.3 \[DCT Configuration Registers\]](#).

| Bits | Description                                                                                                                                                                                                                                                                                                                                                |
|------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31   | <p><b>PerRankTimingEn: per rank timing enable.</b> Read-write. Reset: 0. BIOS: 0. Specifies the mapping between chip selects and a set of programmable timing delays. 1=Each chip select is controlled by a set of timing delays. A maximum of 4 chip selects are supported per channel. 0=Each chip select pair is controlled by a set timing delays.</p> |
| 30   | Reserved.                                                                                                                                                                                                                                                                                                                                                  |
| 29   | <p><b>RefChCmdMgtDis: refresh channel command management disable.</b> Read-write; Same-for-all. Reset: 0. 1=DCTs issue refresh commands independently. 0=DCTs stagger the issue of refresh commands.</p>                                                                                                                                                   |

| 28    | <b>FastSelfRefEntryDis: fast self refresh entry disable.</b> Read-write; Same-for-all. Reset: 1. BIOS: ~D18F2x1B4[FlushWrOnS3StpGnt]. 1=DCT pushes outstanding transactions to memory prior to entering self refresh. 0=DCT enters self refresh immediately unless instructed to push outstanding transactions to memory by D18F2x11C[FlushWrOnStpGnt] or D18F2x1B4[FlushWrOnS3StpGnt].                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |     |             |     |                 |     |                 |     |                 |     |                 |     |                 |     |                 |     |                 |     |                 |
|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-------------|-----|-----------------|-----|-----------------|-----|-----------------|-----|-----------------|-----|-----------------|-----|-----------------|-----|-----------------|-----|-----------------|
| 27:26 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |     |             |     |                 |     |                 |     |                 |     |                 |     |                 |     |                 |     |                 |     |                 |
| 25:24 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |     |             |     |                 |     |                 |     |                 |     |                 |     |                 |     |                 |     |                 |     |                 |
| 23    | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |     |             |     |                 |     |                 |     |                 |     |                 |     |                 |     |                 |     |                 |     |                 |
| 22    | <b>PrtlChPDEnhEn: partial channel power down enh enable.</b> Read-write. Reset: 0. BIOS: 0. Selects the channel idle hysteresis for fast exit/slow exit mode changes when (D18F2x94_dct[3:0][PowerDownMode] & D18F2x84_dct[3:0][PchgPDMoSel]). 1=Hysteresis specified by D18F2x244_dct[3:0][PrtlChPDDynDly]. 0=256 clock hysteresis.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |     |             |     |                 |     |                 |     |                 |     |                 |     |                 |     |                 |     |                 |     |                 |
| 21    | <b>AggrPDEn: aggressive power down enable.</b> Read-write. Reset: 0. BIOS: 1. 1=The DCT places the DRAM devices in precharge power down mode when pages are closed as specified by D18F2x248_dct[3:0]_mp[1:0][AggrPDDelay]. 0=The DCT places the DRAM devices in precharge power down mode when pages are closed as specified by D18F2x90_dct[3:0][DynPageCloseEn].                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |     |             |     |                 |     |                 |     |                 |     |                 |     |                 |     |                 |     |                 |     |                 |
| 20    | <b>BankSwap: swap bank address.</b> Read-write. Reset: 0. BIOS: See BIOS: See 2.9.9.6 [DRAM Training]. 1=Swap the DRAM bank address bits. IF ((D18F2x110[BankSwapAddr8En] ) && D18F2x110[DctSelIntLvAddr]==100b) THEN normalized address bits (7+n):8 are swapped with normalized address bits used for bank address (See D18F2x80_dct[3:0]) ELSE normalized address bits (8+n):9 are swapped with normalized address bits used for bank address; n is the number of bank address bits for the chip select.<br>For example, if D18F2x110[DctSelIntLvAddr]==100b and D18F2x80_dct[3:0][DimmAddrMap]==0111b, then normalized address bits 10:8 are swapped with normalized address bits 15:13. This swap happens before D18F2x94_dct[3:0][BankSwizzleMode] is applied.                                                                                                            |     |             |     |                 |     |                 |     |                 |     |                 |     |                 |     |                 |     |                 |     |                 |
| 19    | <b>PDPhyPSDis: power down phy power save disable.</b> Read-write. Reset: 0. BIOS: 1. 1=Disable phy clock gating during precharge power down (phy LP1 power state). 0=Enable phy clock gating during precharge power down to save power. BIOS must set this bit prior to setting D18F2x94_dct[3:0][PowerDownEn]=1, or before enabling the controller.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |     |             |     |                 |     |                 |     |                 |     |                 |     |                 |     |                 |     |                 |     |                 |
| 18    | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |     |             |     |                 |     |                 |     |                 |     |                 |     |                 |     |                 |     |                 |     |                 |
| 17:16 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |     |             |     |                 |     |                 |     |                 |     |                 |     |                 |     |                 |     |                 |     |                 |
| 15:8  | <b>MrsCtrlWordCS[7:0]: MRS and control word chip select.</b> Read-write. Reset: 0. Specifies the target chip selects used for MRS or control word programming. See D18F2x7C_dct[3:0][SendMrsCmd, SendControlWord]. When used in conjunction with D18F2x7C_dct[3:0][SendMrsCmd], defined only if (~D18F2x7C_dct[3:0][EnDramInit]   ~D18F2x90_dct[3:0][UnbuffDimm]); otherwise, MRS commands are sent to all chip selects.<br><table> <tr> <th>Bit</th><th>Description</th></tr> <tr> <td>[0]</td><td>CS0 is asserted</td></tr> <tr> <td>[1]</td><td>CS1 is asserted</td></tr> <tr> <td>[2]</td><td>CS2 is asserted</td></tr> <tr> <td>[3]</td><td>CS3 is asserted</td></tr> <tr> <td>[4]</td><td>CS4 is asserted</td></tr> <tr> <td>[5]</td><td>CS5 is asserted</td></tr> <tr> <td>[6]</td><td>CS6 is asserted</td></tr> <tr> <td>[7]</td><td>CS7 is asserted</td></tr> </table> | Bit | Description | [0] | CS0 is asserted | [1] | CS1 is asserted | [2] | CS2 is asserted | [3] | CS3 is asserted | [4] | CS4 is asserted | [5] | CS5 is asserted | [6] | CS6 is asserted | [7] | CS7 is asserted |
| Bit   | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |     |             |     |                 |     |                 |     |                 |     |                 |     |                 |     |                 |     |                 |     |                 |
| [0]   | CS0 is asserted                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |     |             |     |                 |     |                 |     |                 |     |                 |     |                 |     |                 |     |                 |     |                 |
| [1]   | CS1 is asserted                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |     |             |     |                 |     |                 |     |                 |     |                 |     |                 |     |                 |     |                 |     |                 |
| [2]   | CS2 is asserted                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |     |             |     |                 |     |                 |     |                 |     |                 |     |                 |     |                 |     |                 |     |                 |
| [3]   | CS3 is asserted                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |     |             |     |                 |     |                 |     |                 |     |                 |     |                 |     |                 |     |                 |     |                 |
| [4]   | CS4 is asserted                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |     |             |     |                 |     |                 |     |                 |     |                 |     |                 |     |                 |     |                 |     |                 |
| [5]   | CS5 is asserted                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |     |             |     |                 |     |                 |     |                 |     |                 |     |                 |     |                 |     |                 |     |                 |
| [6]   | CS6 is asserted                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |     |             |     |                 |     |                 |     |                 |     |                 |     |                 |     |                 |     |                 |     |                 |
| [7]   | CS7 is asserted                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |     |             |     |                 |     |                 |     |                 |     |                 |     |                 |     |                 |     |                 |     |                 |
| 7:6   | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |     |             |     |                 |     |                 |     |                 |     |                 |     |                 |     |                 |     |                 |     |                 |
| 5     | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |     |             |     |                 |     |                 |     |                 |     |                 |     |                 |     |                 |     |                 |     |                 |

|     |           |
|-----|-----------|
| 4   | Reserved. |
| 3:2 | Reserved. |
| 1:0 | Reserved. |

### D18F2xAC DRAM Controller Temperature Status

Cold reset: 0000\_0000h.

| Bits | Description                                                                                                                                                                                                                                                               |
|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:8 | Reserved.                                                                                                                                                                                                                                                                 |
| 7    | Reserved.                                                                                                                                                                                                                                                                 |
| 6    | <b>MemTempHot3: Memory temperature hot, DCT3.</b> See: MemTempHot0.                                                                                                                                                                                                       |
| 5    | Reserved.                                                                                                                                                                                                                                                                 |
| 4    | <b>MemTempHot2: Memory temperature hot, DCT2.</b> See: MemTempHot0.                                                                                                                                                                                                       |
| 3    | Reserved.                                                                                                                                                                                                                                                                 |
| 2    | <b>MemTempHot1: Memory temperature hot, DCT1.</b> See: MemTempHot0.                                                                                                                                                                                                       |
| 1    | Reserved.                                                                                                                                                                                                                                                                 |
| 0    | <b>MemTempHot0: Memory temperature hot, DCT0.</b> Read; Write-1-to-clear. 1=The EVENT_L pin was asserted indicating the memory temperature exceeded the normal operating limit; the DCT may be throttling the interface to aid in cooling. See <a href="#">D18F2xA4</a> . |

### D18F2xF8 P-state Power Information 1

Read-only.

| Bits          | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |               |                    |     |                                   |     |                                     |     |                                      |     |          |
|---------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|--------------------|-----|-----------------------------------|-----|-------------------------------------|-----|--------------------------------------|-----|----------|
| 31:24         | <b>PwrValue3: P3 power value.</b> See PwrValue0. Value: Product-specific.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |               |                    |     |                                   |     |                                     |     |                                      |     |          |
| 23:16         | <b>PwrValue2: P2 power value.</b> See PwrValue0. Value: Product-specific.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |               |                    |     |                                   |     |                                     |     |                                      |     |          |
| 15:8          | <b>PwrValue1: P1 power value.</b> See PwrValue0. Value: Product-specific.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |               |                    |     |                                   |     |                                     |     |                                      |     |          |
| 7:0           | <p><b>PwrValue0: P0 power value.</b> PwrValue and PwrDiv together specify the expected power draw of a single core in P0 and 1/NumCores of the Northbridge in the NB P-state as specified by <a href="#">MSRC001_00[6B:64][NbPstate]</a>. NumCores is defined to be the number of cores per node at cold reset. Value: Product-specific.</p> <table> <tr> <th><u>PwrDiv</u></th><th><u>Description</u></th></tr> <tr> <td>00b</td><td>PwrValue / 1 W, Range: 0 to 255 W</td></tr> <tr> <td>01b</td><td>PwrValue / 10 W, Range: 0 to 25.5 W</td></tr> <tr> <td>10b</td><td>PwrValue / 100 W, Range: 0 to 2.55 W</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table> | <u>PwrDiv</u> | <u>Description</u> | 00b | PwrValue / 1 W, Range: 0 to 255 W | 01b | PwrValue / 10 W, Range: 0 to 25.5 W | 10b | PwrValue / 100 W, Range: 0 to 2.55 W | 11b | Reserved |
| <u>PwrDiv</u> | <u>Description</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |               |                    |     |                                   |     |                                     |     |                                      |     |          |
| 00b           | PwrValue / 1 W, Range: 0 to 255 W                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |               |                    |     |                                   |     |                                     |     |                                      |     |          |
| 01b           | PwrValue / 10 W, Range: 0 to 25.5 W                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |               |                    |     |                                   |     |                                     |     |                                      |     |          |
| 10b           | PwrValue / 100 W, Range: 0 to 2.55 W                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |               |                    |     |                                   |     |                                     |     |                                      |     |          |
| 11b           | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |               |                    |     |                                   |     |                                     |     |                                      |     |          |

### D18F2xFC P-state Power Information 2

Read-only.

| Bits  | Description |
|-------|-------------|
| 31:24 | Reserved.   |

|       |                                                                                                      |
|-------|------------------------------------------------------------------------------------------------------|
| 23:22 | <b>PwrDiv7: P7 power divisor.</b> See <a href="#">D18F2xF8[PwrValue0]</a> . Value: Product-specific. |
| 21:20 | <b>PwrDiv6: P6 power divisor.</b> See <a href="#">D18F2xF8[PwrValue0]</a> . Value: Product-specific. |
| 19:18 | <b>PwrDiv5: P5 power divisor.</b> See <a href="#">D18F2xF8[PwrValue0]</a> . Value: Product-specific. |
| 17:16 | <b>PwrDiv4: P4 power divisor.</b> See <a href="#">D18F2xF8[PwrValue0]</a> . Value: Product-specific. |
| 15:14 | <b>PwrDiv3: P3 power divisor.</b> See <a href="#">D18F2xF8[PwrValue0]</a> . Value: Product-specific. |
| 13:12 | <b>PwrDiv2: P2 power divisor.</b> See <a href="#">D18F2xF8[PwrValue0]</a> . Value: Product-specific. |
| 11:10 | <b>PwrDiv1: P1 power divisor.</b> See <a href="#">D18F2xF8[PwrValue0]</a> . Value: Product-specific. |
| 9:8   | <b>PwrDiv0: P0 power divisor.</b> See <a href="#">D18F2xF8[PwrValue0]</a> . Value: Product-specific. |
| 7:0   | <b>PwrValue4: P4 power value.</b> See <a href="#">D18F2xF8[PwrValue0]</a> . Value: Product-specific. |

### D18F2x104 P-state Power Information 3

Read-only.

| Bits  | Description                                                                                          |
|-------|------------------------------------------------------------------------------------------------------|
| 31:24 | Reserved.                                                                                            |
| 23:16 | <b>PwrValue7: P7 power value.</b> See <a href="#">D18F2xF8[PwrValue0]</a> . Value: Product-specific. |
| 15:8  | <b>PwrValue6: P6 power value.</b> See <a href="#">D18F2xF8[PwrValue0]</a> . Value: Product-specific. |
| 7:0   | <b>PwrValue5: P5 power value.</b> See <a href="#">D18F2xF8[PwrValue0]</a> . Value: Product-specific. |

### D18F2x110 DRAM Controller Select Low

Reset: 0000\_0000h.

| Bits  | Description                                                                                                                                                                                                                                                             |
|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:11 | Reserved.                                                                                                                                                                                                                                                               |
| 10    | <b>MemCleared: memory cleared.</b> Read-only; updated-by-hardware. 1=Memory has been cleared since the last warm reset. This bit is set by MemClrInit. See MemClrInit.                                                                                                  |
| 9     | <b>MemClrBusy: memory clear busy.</b> Read-only; updated-by-hardware. 1=The memory clear operation in either of the DCTs is in progress. Reads or writes to DRAM while the memory clear operation is in progress result in undefined behavior.                          |
| 8     | <b>DramEnable: DRAM enabled.</b> Read-only. 1=All of the used DCTs are initialized (see <a href="#">2.9.9.5 [DRAM Device Initialization and Training]</a> ) or have exited from self refresh ( <a href="#">D18F2x90_dct[3:0][ExitSelfRef]</a> transitions from 1 to 0). |

| 7:6       | <p><b>DctSelIntLvAddr[1:0]: DRAM controller select channel interleave address bit [1:0].</b> IF (D18F2x118[LockDramCfg]) THEN Read-only. ELSE Read-write. ENDIF. DctSelIntLvAddr = {D18F2x114[DctSelIntLvAddr[2]], D18F2x110[DctSelIntLvAddr[1:0]]}. BIOS: 100b. Specifies how interleaving is selected between the DCTs.</p> <p>IF (POPCNT(DctIntLvEn) == 2) THEN</p> <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>011b-000b</td><td>Reserved</td></tr> <tr> <td>100b</td><td>Address bit 8</td></tr> <tr> <td>101b</td><td>Address bit 9</td></tr> <tr> <td>111b-110b</td><td>Reserved</td></tr> </table> <p>ELSEIF (POPCNT(DctIntLvEn) == 4) THEN</p> <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>011b-000b</td><td>Reserved</td></tr> <tr> <td>100b</td><td>Address bit [9:8]</td></tr> <tr> <td>101b</td><td>Address bit [10:9]</td></tr> <tr> <td>111b-110b</td><td>Reserved</td></tr> </table> <p>ENDIF.</p>                                                                   | Bits | Description | 011b-000b | Reserved | 100b | Address bit 8 | 101b | Address bit 9 | 111b-110b | Reserved | Bits | Description | 011b-000b | Reserved | 100b | Address bit [9:8] | 101b | Address bit [10:9] | 111b-110b | Reserved |
|-----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|-----------|----------|------|---------------|------|---------------|-----------|----------|------|-------------|-----------|----------|------|-------------------|------|--------------------|-----------|----------|
| Bits      | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |      |             |           |          |      |               |      |               |           |          |      |             |           |          |      |                   |      |                    |           |          |
| 011b-000b | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |      |             |           |          |      |               |      |               |           |          |      |             |           |          |      |                   |      |                    |           |          |
| 100b      | Address bit 8                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |      |             |           |          |      |               |      |               |           |          |      |             |           |          |      |                   |      |                    |           |          |
| 101b      | Address bit 9                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |      |             |           |          |      |               |      |               |           |          |      |             |           |          |      |                   |      |                    |           |          |
| 111b-110b | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |      |             |           |          |      |               |      |               |           |          |      |             |           |          |      |                   |      |                    |           |          |
| Bits      | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |      |             |           |          |      |               |      |               |           |          |      |             |           |          |      |                   |      |                    |           |          |
| 011b-000b | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |      |             |           |          |      |               |      |               |           |          |      |             |           |          |      |                   |      |                    |           |          |
| 100b      | Address bit [9:8]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |      |             |           |          |      |               |      |               |           |          |      |             |           |          |      |                   |      |                    |           |          |
| 101b      | Address bit [10:9]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |      |             |           |          |      |               |      |               |           |          |      |             |           |          |      |                   |      |                    |           |          |
| 111b-110b | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |      |             |           |          |      |               |      |               |           |          |      |             |           |          |      |                   |      |                    |           |          |
| 5         | <p><b>DctDatIntLv: DRAM controller data interleave enable.</b> IF (D18F2x118[LockDramCfg]) THEN Read-only. ELSE Read-write. ENDIF. BIOS: D18F3x44[DramEccEn]. 1=DRAM data bits from every two consecutive 64-bit DRAM lines are interleaved in the ECC calculation such that a dead bit of a DRAM device is correctable.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |      |             |           |          |      |               |      |               |           |          |      |             |           |          |      |                   |      |                    |           |          |
| 4         | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |      |             |           |          |      |               |      |               |           |          |      |             |           |          |      |                   |      |                    |           |          |
| 3         | <p><b>MemClrInit: memory clear initialization.</b> IF (D18F2x118[LockDramCfg]) THEN Read-only. ELSE Read-write. ENDIF. 1=The node writes 0's to all locations of system memory attached to the node and sets the MemCleared bit. The status of the memory clear operation can be determined by reading the MemClrBusy and MemCleared bits. This command is ignored if MemClrBusy=1 when the command is received. DramEnable must be set before setting MemClrInit. The memory prefetcher must be disabled by setting D18F2x11C[PrefIoDis] and D18F2x11C[PrefCpuDis] before memory clear initialization and then can be re-enabled when MemCleared=1. Channel interleaving and memory hole remapping must be disabled before setting MemClrInit. See D18F1x2[1,0][C,4][DctIntLvEn] and D18F1x2[1,0][8,0][LgcyMmioHoleEn]. Software must temporarily configure each channel with a Base/Limit register pair, initiate memory clear, then reprogram these to the desired configuration when memory clear is complete.</p> |      |             |           |          |      |               |      |               |           |          |      |             |           |          |      |                   |      |                    |           |          |
| 2         | <p><b>BankSwapAddr8En: Bank swap to address bit 8 enable.</b> Read-write. BIOS:(D18F2xA8_dct[3:0][BankSwap] &amp;&amp; D18F2x110[DctSelIntLvAddr]==100b). See D18F2xA8_dct[3:0][BankSwap].</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |      |             |           |          |      |               |      |               |           |          |      |             |           |          |      |                   |      |                    |           |          |
| 1:0       | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |      |             |           |          |      |               |      |               |           |          |      |             |           |          |      |                   |      |                    |           |          |

### D18F2x114 DRAM Controller Select High

IF (D18F2x118[LockDramCfg]) THEN Read-only. ELSE Read-write. ENDIF. Reset: 0000\_0000h.

| Bits  | Description |
|-------|-------------|
| 31:10 | Reserved.   |

|     |                                                                                                                                             |
|-----|---------------------------------------------------------------------------------------------------------------------------------------------|
| 9   | <b>DctSelIntLvAddr[2]: DRAM controller select channel interleave address bit [2].</b> See <a href="#">D18F2x110[DctSelIntLvAddr[1:0]]</a> . |
| 8:0 | Reserved.                                                                                                                                   |

### D18F2x118 Memory Controller Configuration Low

Fields in this register (bits[17:0]) indicate priority of request types. Variable priority requests enter the memory controller as medium priority and are promoted to high priority if they have not been serviced in the time specified by MctVarPriCntLmt. This feature may be useful for isochronous IO traffic. If isochronous traffic is specified to be high priority, it may have an adverse effect on the bandwidth and performance of the devices associated with the other types of traffic. However, if isochronous traffic is specified as medium priority, the processor may not meet the isochronous bandwidth and latency requirements. The variable priority allows the memory controller to optimize DRAM transactions until isochronous traffic reaches a time threshold and must be serviced more quickly.

| Bits  | Description                                                                                                                                                                                                                            |                    |             |                    |
|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|-------------|--------------------|
| 31:28 | <b>MctVarPriCntLmt: variable priority time limit.</b> Read-write. Reset: 0000b. BIOS: 0001b.                                                                                                                                           |                    |             |                    |
|       | <u>Bits</u>                                                                                                                                                                                                                            | <u>Description</u> | <u>Bits</u> | <u>Description</u> |
|       | 0000b                                                                                                                                                                                                                                  | 80ns               | 1000b       | 720ns              |
|       | 0001b                                                                                                                                                                                                                                  | 160ns              | 1001b       | 800ns              |
|       | 0010b                                                                                                                                                                                                                                  | 240ns              | 1010b       | 880ns              |
|       | 0011b                                                                                                                                                                                                                                  | 320ns              | 1011b       | 960ns              |
|       | 0100b                                                                                                                                                                                                                                  | 400ns              | 1100b       | 1040ns             |
|       | 0101b                                                                                                                                                                                                                                  | 480ns              | 1101b       | 1120ns             |
|       | 0110b                                                                                                                                                                                                                                  | 560ns              | 1110b       | 1200ns             |
| 0111b | 640ns                                                                                                                                                                                                                                  | 1111b              | 1280ns      |                    |
| 27    | Reserved.                                                                                                                                                                                                                              |                    |             |                    |
| 26:24 | <b>McqHiPriByPassMax: memory controller high priority bypass max.</b> Read-write. Reset: 100b. Specifies the number high-priority operations that are allowed before yielding to medium or low-priority operations. 000b is reserved.  |                    |             |                    |
| 23    | Reserved.                                                                                                                                                                                                                              |                    |             |                    |
| 22:20 | <b>McqMedPriByPassMax: memory controller medium bypass low priority max.</b> Read-write. Reset: 100b. Specifies the number of medium-priority operations that are allowed before yielding to low-priority operations. 000b is reserved |                    |             |                    |

| 19          | <p><b>LockDramCfg.</b> Write-1-only. Reset: 0. BIOS: See 2.9.13 [DRAM CC6/PC6 Storage], 2.5.3.2.3.3 [Core C6 (CC6) State].</p> <p>The following registers are read-only if LockDramCfg=1; otherwise the access type is specified by the register:</p> <ul style="list-style-type: none"> <li>• D18F1xF0 [DRAM Hole Address]</li> <li>• D18F2x[5C:40]_dct[3:0] [DRAM CS Base Address]</li> <li>• D18F2x[6C:60]_dct[3:0] [DRAM CS Mask]</li> <li>• D18F2x80_dct[3:0] [DRAM Bank Address Mapping]</li> <li>• D18F2x110 [DRAM Controller Select Low]</li> <li>• D18F2x114 [DRAM Controller Select High]</li> <li>• D18F2x250_dct[3:0] [DRAM Loopback and Training Control]</li> <li>• D18F4x128[CoreStateSaveDestNode]</li> <li>• D18F1x[17C:140,7C:40] [DRAM Base/Limit]</li> <li>• D18F1x120 [DRAM Base System Address]</li> <li>• D18F1x124 [DRAM Limit System Address]</li> <li>• D18F2x118[CC6SaveEn]</li> </ul> |             |                    |     |        |     |          |     |      |     |          |
|-------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|--------------------|-----|--------|-----|----------|-----|------|-----|----------|
| 18          | <p><b>CC6SaveEn.</b> IF (D18F2x118[LockDramCfg]) THEN Read-only. ELSE Read-write. ENDIF. Reset: 0. 1=CC6 save area is enabled. See 2.5.3.2.7 [BIOS Requirements for Initialization]. BIOS: (D18F4x118[PwrGateEnCstAct0]   D18F4x118[PwrGateEnCstAct1]   D18F4x11C[PwrGateEnCstAct2]).</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |             |                    |     |        |     |          |     |      |     |          |
| 17:16       | <p><b>MctPriScrub: scrubber priority.</b> Read-write. Reset: 00b.</p> <table> <tr> <th><u>Bits</u></th><th><u>Description</u></th></tr> <tr> <td>00b</td><td>Medium</td></tr> <tr> <td>01b</td><td>Reserved</td></tr> <tr> <td>10b</td><td>High</td></tr> <tr> <td>11b</td><td>Variable</td></tr> </table>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <u>Bits</u> | <u>Description</u> | 00b | Medium | 01b | Reserved | 10b | High | 11b | Variable |
| <u>Bits</u> | <u>Description</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |             |                    |     |        |     |          |     |      |     |          |
| 00b         | Medium                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |             |                    |     |        |     |          |     |      |     |          |
| 01b         | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |             |                    |     |        |     |          |     |      |     |          |
| 10b         | High                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |             |                    |     |        |     |          |     |      |     |          |
| 11b         | Variable                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |             |                    |     |        |     |          |     |      |     |          |
| 15:14       | <p><b>MctPriTrace: trace-mode request priority.</b> See: MctPriCpuRd. Read-write. Reset: 10b. This must be set to high.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |             |                    |     |        |     |          |     |      |     |          |
| 13:12       | <p><b>MctPriIloc: display refresh read priority.</b> See: MctPriCpuRd. Read-write. Reset: 10b.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |             |                    |     |        |     |          |     |      |     |          |
| 11:10       | <p><b>MctPriWr: default write priority.</b> See: MctPriCpuRd. Read-write. Reset: 01b.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |             |                    |     |        |     |          |     |      |     |          |
| 9:8         | <p><b>MctPriDefault: default non-write priority.</b> See: MctPriCpuRd. Read-write. Reset: 00b.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |             |                    |     |        |     |          |     |      |     |          |
| 7:6         | <p><b>MctPriIlocWr: IO write with the isoch bit set priority.</b> See: MctPriCpuRd. Read-write. Reset: 00b. This does not apply to isochronous traffic that is classified as display refresh.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |             |                    |     |        |     |          |     |      |     |          |
| 5:4         | <p><b>MctPriIlocRd: IO read with the isoch bit set priority.</b> See: MctPriCpuRd. Read-write. Reset: 10b. This does not apply to isochronous traffic that is classified as display refresh.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |             |                    |     |        |     |          |     |      |     |          |
| 3:2         | <p><b>MctPriCpuWr: CPU write priority.</b> See: MctPriCpuRd. Read-write. Reset: 01b.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |             |                    |     |        |     |          |     |      |     |          |
| 1:0         | <p><b>MctPriCpuRd: CPU read priority.</b> Read-write. Reset: 00b.</p> <table> <tr> <th><u>Bits</u></th><th><u>Description</u></th></tr> <tr> <td>00b</td><td>Medium</td></tr> <tr> <td>01b</td><td>Low</td></tr> <tr> <td>10b</td><td>High</td></tr> <tr> <td>11b</td><td>Variable</td></tr> </table>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <u>Bits</u> | <u>Description</u> | 00b | Medium | 01b | Low      | 10b | High | 11b | Variable |
| <u>Bits</u> | <u>Description</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |             |                    |     |        |     |          |     |      |     |          |
| 00b         | Medium                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |             |                    |     |        |     |          |     |      |     |          |
| 01b         | Low                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |             |                    |     |        |     |          |     |      |     |          |
| 10b         | High                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |             |                    |     |        |     |          |     |      |     |          |
| 11b         | Variable                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |             |                    |     |        |     |          |     |      |     |          |

### D18F2x11C Memory Controller Configuration High

The two main functions of this register are to control write bursting and memory prefetching.



**Write bursting.** DctWrLimit and MctWrLimit specify how writes may be burst from the MCT into the DCT to improve DRAM efficiency. When the number of writes in the MCT reaches the value specified in MctWrLimit, then they are all burst to the DCTs at once. Prior to reaching the watermark, a limited number of writes can be passed to the DCTs (specified by DctWrLimit), tagged as low priority, for the DCTs to complete when otherwise idle. Rules regarding write bursting:

- Write bursting mode only applies to low-priority writes. Medium and high priority writes are not withheld from the DCTs for write bursting.
- If write bursting is enabled, writes stay in the MCQ until the threshold specified by MctWrLimit is reached.
- Once the threshold is reached, all writes in MCQ are converted to medium priority.
- Any write in MCQ that matches the address of a subsequent access is promoted to either medium priority or the priority of the subsequent access, whichever is higher.
- DctWrLimit only applies to low-priority writes.

**Memory prefetching.** The MCT prefetcher detects stride patterns in the stream of requests and then, for predictable stride patterns, generates prefetch requests. A stride pattern is a pattern of requests through system memory that are the same number of cachelines apart. The prefetcher supports strides of -4 to +4 cachelines, which can include alternating patterns (e.g. +1, +2, +1, +2), and can prefetch 1, 2, 3, 4, or 5 cachelines ahead, depending on the confidence. In addition, a fixed stride mode (non-alternating) may be used for IO requests which often have fixed stride patterns. This mode bypasses the stride predictor such that CPU-access stride predictions are not adversely affected by IO streams.

The MCT tracks several stride patterns simultaneously. Each of these has a confidence level associated with it that varies as follows:

- Each time a request is received that matches the stride pattern, the confidence level increases by one.
- Each time a request is received within +/- 4 cachelines of the last requested cacheline in the pattern that does not match the pattern, then the confidence level decreases by one.
- When the confidence level reaches the saturation point specified by PrefConfSat, then it no longer increments.

Each request that is not within +/- 4 cachelines of the last requested cacheline line of all the stride patterns tracked initiates a new stride pattern by displacing one of the existing least-recently-used stride patterns.

The memory prefetcher uses an adaptive prefetch scheme to adjust the prefetch distance based upon the buffer space available for prefetch request data. The adaptive scheme counts the total number of prefetch requests and the number of prefetch requests that cannot return data because of buffer availability. After every 16 prefetch requests, the prefetcher uses the following rules to adjust the prefetch distance:

- If the ratio of prefetch requests that cannot return data to total prefetch requests is greater than or equal to `D18F2x1B0[AdapPrefMissRatio]` then the prefetch distance is reduced by `D18F2x1B0[AdapPrefNegativeStep]`.
- If the ratio of prefetch requests that cannot return data to total prefetch requests is less than `D18F2x1B0[AdapPrefMissRatio]` then the prefetch distance is increased by `D18F2x1B0[AdapPrefPositiveStep]`.
- If the adjusted prefetch distance is greater than the prefetch distance defined for the current confidence level, the prefetch distance for the current confidence level is used.

The adaptive prefetch scheme supports fractional prefetch distances by alternating between two whole number prefetch distances. For example a prefetch distance of 1.25 causes a prefetch distance sequence of: 1, 1, 1, 2, 1, 1, 1, 2.

| Bits      | Description                                                                                                                                                                                                                                                                                                                                                                                                                |      |             |      |    |           |                 |      |    |     |          |
|-----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|------|----|-----------|-----------------|------|----|-----|----------|
| 31        | <b>MctScrubEn: MCT scrub enable.</b> Read-write. Reset: 0. 1=Enables periodic flushing of prefetches and writes based on the DRAM scrub rate. This is used to ensure that prefetch and write data aging is not so long that soft errors accumulate and become uncorrectable. When enabled, each DRAM scrub event causes a single prefetch to be de-allocated (the oldest one) and all queued writes to be flushed to DRAM. |      |             |      |    |           |                 |      |    |     |          |
| 30        | <b>FlushWr: flush writes command.</b> Read; write-1-only; cleared-by-hardware. Reset: 0. Setting this bit causes write bursting to be canceled and all outstanding writes to be flushed to DRAM. This bit is cleared when all writes are flushed to DRAM.                                                                                                                                                                  |      |             |      |    |           |                 |      |    |     |          |
| 29        | <b>FlushWrOnStpGnt: flush writes on stop-grant.</b> Read-write. Reset: 0. BIOS: <a href="#">~D18F2x1B4</a> [FlushWrOnS3StpGnt]. 1=Causes write bursting to be canceled and all outstanding writes to be flushed to DRAM when in the stop-grant state.                                                                                                                                                                      |      |             |      |    |           |                 |      |    |     |          |
| 28        | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                  |      |             |      |    |           |                 |      |    |     |          |
| 27:25     | <b>PrefThreeConf: prefetch three-ahead confidence.</b> Read-write. Reset: 100b. BIOS: 110b. Confidence level required in order to prefetch three cachelines ahead (same encoding as PrefTwoConf below).                                                                                                                                                                                                                    |      |             |      |    |           |                 |      |    |     |          |
| 24:22     | <b>PrefTwoConf: prefetch two-ahead confidence.</b> Read-write. Reset: 011b. BIOS: 011b. Confidence level required in order to prefetch two cachelines ahead.<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>000b</td><td>0</td></tr> <tr> <td>110b-001b</td><td>[PrefTwoConf*2]</td></tr> <tr> <td>111b</td><td>14</td></tr> </table>                                                                     | Bits | Description | 000b | 0  | 110b-001b | [PrefTwoConf*2] | 111b | 14 |     |          |
| Bits      | Description                                                                                                                                                                                                                                                                                                                                                                                                                |      |             |      |    |           |                 |      |    |     |          |
| 000b      | 0                                                                                                                                                                                                                                                                                                                                                                                                                          |      |             |      |    |           |                 |      |    |     |          |
| 110b-001b | [PrefTwoConf*2]                                                                                                                                                                                                                                                                                                                                                                                                            |      |             |      |    |           |                 |      |    |     |          |
| 111b      | 14                                                                                                                                                                                                                                                                                                                                                                                                                         |      |             |      |    |           |                 |      |    |     |          |
| 21:20     | <b>PrefOneConf: prefetch one-ahead confidence.</b> Read-write. Reset: 10b. BIOS: 10b. Confidence level required in order to prefetch one ahead (0 through 3).                                                                                                                                                                                                                                                              |      |             |      |    |           |                 |      |    |     |          |
| 19:18     | <b>PrefConfSat: prefetch confidence saturation.</b> Read-write. Reset: 00b. BIOS: 00b. Specifies the point at which prefetch confidence level saturates and stops incrementing.<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>15</td></tr> <tr> <td>01b</td><td>7</td></tr> <tr> <td>10b</td><td>3</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>                                | Bits | Description | 00b  | 15 | 01b       | 7               | 10b  | 3  | 11b | Reserved |
| Bits      | Description                                                                                                                                                                                                                                                                                                                                                                                                                |      |             |      |    |           |                 |      |    |     |          |
| 00b       | 15                                                                                                                                                                                                                                                                                                                                                                                                                         |      |             |      |    |           |                 |      |    |     |          |
| 01b       | 7                                                                                                                                                                                                                                                                                                                                                                                                                          |      |             |      |    |           |                 |      |    |     |          |
| 10b       | 3                                                                                                                                                                                                                                                                                                                                                                                                                          |      |             |      |    |           |                 |      |    |     |          |
| 11b       | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                   |      |             |      |    |           |                 |      |    |     |          |
| 17:16     | <b>PrefFixDist: prefetch fixed stride distance.</b> Read-write. Reset: 00b. Specifies the distance to prefetch ahead if in fixed stride mode. 00b=1 cacheline; 01b=2 cachelines; 10b=3 cachelines; 11b=4 cachelines.                                                                                                                                                                                                       |      |             |      |    |           |                 |      |    |     |          |
| 15        | <b>PrefFixStrideEn: prefetch fixed stride enable.</b> Read-write. Reset: 0. 1=The prefetch stride for all requests (CPU and IO) is fixed (non-alternating).                                                                                                                                                                                                                                                                |      |             |      |    |           |                 |      |    |     |          |
| 14        | <b>PrefIoFixStrideEn: Prefetch IO fixed stride enable.</b> Read-write. Reset: 0. 1=The prefetch stride for IO requests is fixed (non-alternating).                                                                                                                                                                                                                                                                         |      |             |      |    |           |                 |      |    |     |          |
| 13        | <b>PrefIoDis: prefetch IO-access disable.</b> Read-write. Reset: 1. BIOS: 0. 1=Disables IO requests from triggering prefetch requests.                                                                                                                                                                                                                                                                                     |      |             |      |    |           |                 |      |    |     |          |
| 12        | <b>PrefCpuDis: prefetch CPU-access disable.</b> Read-write. Reset: 1. BIOS: 0. 1=Disables CPU requests from triggering prefetch requests.                                                                                                                                                                                                                                                                                  |      |             |      |    |           |                 |      |    |     |          |
| 11:7      | <b>MctPrefReqLimit: memory controller prefetch request limit.</b> Read-write. Reset: 1Eh. BIOS: 1Dh. Specifies the maximum number of outstanding prefetch requests allowed. See <a href="#">D18F3x78</a> for restrictions on this field.                                                                                                                                                                                   |      |             |      |    |           |                 |      |    |     |          |

| 6:2     | <b>MctWrLimit: memory controller write-burst limit.</b> Read-write. Reset: 1Fh. BIOS: 0Ah. Specifies the number of writes in the memory controller queue before they are burst into the DCTs.<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00h</td><td>32</td></tr> <tr> <td>1Dh-01h</td><td>[32-MctWrLimit]</td></tr> <tr> <td>1Eh</td><td>2</td></tr> <tr> <td>1Fh</td><td>Write bursting disabled</td></tr> </table>                                             | Bits | Description | 00h | 32 | 1Dh-01h | [32-MctWrLimit] | 1Eh | 2 | 1Fh | Write bursting disabled |
|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|-----|----|---------|-----------------|-----|---|-----|-------------------------|
| Bits    | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |      |             |     |    |         |                 |     |   |     |                         |
| 00h     | 32                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |      |             |     |    |         |                 |     |   |     |                         |
| 1Dh-01h | [32-MctWrLimit]                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |      |             |     |    |         |                 |     |   |     |                         |
| 1Eh     | 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |      |             |     |    |         |                 |     |   |     |                         |
| 1Fh     | Write bursting disabled                                                                                                                                                                                                                                                                                                                                                                                                                                                                |      |             |     |    |         |                 |     |   |     |                         |
| 1:0     | <b>DctWrLimit: DRAM controller write limit.</b> Read-write. Reset: 00b. BIOS: 01b. Specifies the maximum number of writes allowed in the DCT queue when write bursting is enabled, prior to when the number of writes in MCQ exceeds the watermark specified by MctWrLimit.<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>0</td></tr> <tr> <td>01b</td><td>2</td></tr> <tr> <td>10b</td><td>4</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table> | Bits | Description | 00b | 0  | 01b     | 2               | 10b | 4 | 11b | Reserved                |
| Bits    | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |      |             |     |    |         |                 |     |   |     |                         |
| 00b     | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |      |             |     |    |         |                 |     |   |     |                         |
| 01b     | 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |      |             |     |    |         |                 |     |   |     |                         |
| 10b     | 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |      |             |     |    |         |                 |     |   |     |                         |
| 11b     | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |      |             |     |    |         |                 |     |   |     |                         |

### D18F2x1B0 Extended Memory Controller Configuration Low

The main function of this register is to control the memory prefetcher. See [D18F2x11C \[Memory Controller Configuration High\]](#) about the adaptive prefetch scheme.

**Table 180: BIOS Recommendations** for D18F2x1B[4:0]

| Condition | D18F2x1B0    | D18F2x1B4     |               |
|-----------|--------------|---------------|---------------|
| DdrRate   | DcqBwThrotWm | DcqBwThrotWm1 | DcqBwThrotWm2 |
| 667       | 0h           | 3h            | 4h            |
| 800       | 0h           | 3h            | 5h            |
| 1066      | 0h           | 4h            | 6h            |
| 1333      | 0h           | 5h            | 8h            |
| 1600      | 0h           | 6h            | 9h            |
| 1866      | 0h           | 7h            | Ah            |
| 2133      | 0h           | 8h            | Ch            |

| Bits      | Description                                                                                                                                                                                                                                                                                                                                                                                                                        |      |             |      |   |           |                  |      |    |
|-----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|------|---|-----------|------------------|------|----|
| 31:28     | <b>DcqBwThrotWm: dcq bandwidth throttle watermark.</b> Read-write. Reset: 3h. BIOS: <a href="#">Table 180</a> . Specifies the number of outstanding DRAM read requests before new DRAM prefetch requests and speculative prefetch requests are throttled. 0h=Throttling is disabled. Legal values are 0h through Ch. Programming this field to a non-zero value disables <a href="#">D18F2x1B4</a> [DcqBwThrotWm1, DcqBwThrotWm2]. |      |             |      |   |           |                  |      |    |
| 27:25     | <b>PrefFiveConf: prefetch five-ahead confidence.</b> Read-write. Reset: 110b. BIOS: 111b. Confidence level required in order to prefetch five cachelines ahead.<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>000b</td><td>0</td></tr> <tr> <td>110b-001b</td><td>[PrefFiveConf*2]</td></tr> <tr> <td>111b</td><td>14</td></tr> </table>                                                                         | Bits | Description | 000b | 0 | 110b-001b | [PrefFiveConf*2] | 111b | 14 |
| Bits      | Description                                                                                                                                                                                                                                                                                                                                                                                                                        |      |             |      |   |           |                  |      |    |
| 000b      | 0                                                                                                                                                                                                                                                                                                                                                                                                                                  |      |             |      |   |           |                  |      |    |
| 110b-001b | [PrefFiveConf*2]                                                                                                                                                                                                                                                                                                                                                                                                                   |      |             |      |   |           |                  |      |    |
| 111b      | 14                                                                                                                                                                                                                                                                                                                                                                                                                                 |      |             |      |   |           |                  |      |    |

| 24:22     | <b>PrefFourConf: prefetch four-ahead confidence.</b> Read-write. Reset: 101b. BIOS: 111b. Confidence level required in order to prefetch four cachelines ahead.<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>000b</td><td>0</td></tr> <tr> <td>110b-001b</td><td>[PrefFourConf*2]</td></tr> <tr> <td>111b</td><td>14</td></tr> </table>                                                                                                                                                                                       | Bits | Description | 000b | 0                                             | 110b-001b | [PrefFourConf*2] | 111b | 14   |     |       |
|-----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|------|-----------------------------------------------|-----------|------------------|------|------|-----|-------|
| Bits      | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |      |             |      |                                               |           |                  |      |      |     |       |
| 000b      | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |      |             |      |                                               |           |                  |      |      |     |       |
| 110b-001b | [PrefFourConf*2]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |      |             |      |                                               |           |                  |      |      |     |       |
| 111b      | 14                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |      |             |      |                                               |           |                  |      |      |     |       |
| 21        | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |      |             |      |                                               |           |                  |      |      |     |       |
| 20        | <b>DbIPrefEn: double prefetch enable.</b> Read-write. Reset: 0. 1=The memory prefetcher only generates prefetch requests when it is able to generate a pair of prefetch requests to consecutive cache lines.                                                                                                                                                                                                                                                                                                                                     |      |             |      |                                               |           |                  |      |      |     |       |
| 19:18     | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |      |             |      |                                               |           |                  |      |      |     |       |
| 17:13     | Reserved. Reset: 11100b.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |      |             |      |                                               |           |                  |      |      |     |       |
| 12        | <b>EnSplitDctLimits: split DCT write limits enable.</b> Read-write. Reset: 0. BIOS: 1. 1=The number of writes specified by <a href="#">D18F2x11C</a> [DctWrLimit, MctWrLimit] is per DCT. 0=The number of writes specified by <a href="#">D18F2x11C</a> [DctWrLimit, MctWrLimit] is for the even[0,2] or odd[1,3] DCT channels. 0=The number of writes specified by <a href="#">D18F2x11C</a> [DctWrLimit, MctWrLimit] is total writes independent of DCT. Setting this bit also affects the encoding of <a href="#">D18F2x11C</a> [DctWrLimit]. |      |             |      |                                               |           |                  |      |      |     |       |
| 11        | <b>DisloCohPref: disable coherent prefetched for IO.</b> Read-write. Reset: 0. 1=Probes are not generated for prefetches generated for reads from IO devices.                                                                                                                                                                                                                                                                                                                                                                                    |      |             |      |                                               |           |                  |      |      |     |       |
| 10:8      | <b>CohPrefPrbLmt: coherent prefetch probe limit.</b> Read-write. Reset: 000b. BIOS: 000b. Specifies the maximum number of probes that can be outstanding for memory prefetch requests.<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>000b</td><td>Probing disabled for memory prefetch requests</td></tr> <tr> <td>111b-001b</td><td>Reserved.</td></tr> </table>                                                                                                                                                              | Bits | Description | 000b | Probing disabled for memory prefetch requests | 111b-001b | Reserved.        |      |      |     |       |
| Bits      | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |      |             |      |                                               |           |                  |      |      |     |       |
| 000b      | Probing disabled for memory prefetch requests                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |      |             |      |                                               |           |                  |      |      |     |       |
| 111b-001b | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |      |             |      |                                               |           |                  |      |      |     |       |
| 7:6       | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |      |             |      |                                               |           |                  |      |      |     |       |
| 5:4       | <b>AdapPrefNegativeStep: adaptive prefetch negative step.</b> Read-write. Reset: 00b. BIOS: 00b. Specifies the step size that the adaptive prefetch scheme uses when decreasing the prefetch distance.<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>2/16</td></tr> <tr> <td>01b</td><td>4/16</td></tr> <tr> <td>10b</td><td>8/16</td></tr> <tr> <td>11b</td><td>16/16</td></tr> </table>                                                                                                                          | Bits | Description | 00b  | 2/16                                          | 01b       | 4/16             | 10b  | 8/16 | 11b | 16/16 |
| Bits      | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |      |             |      |                                               |           |                  |      |      |     |       |
| 00b       | 2/16                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |      |             |      |                                               |           |                  |      |      |     |       |
| 01b       | 4/16                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |      |             |      |                                               |           |                  |      |      |     |       |
| 10b       | 8/16                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |      |             |      |                                               |           |                  |      |      |     |       |
| 11b       | 16/16                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |      |             |      |                                               |           |                  |      |      |     |       |
| 3:2       | <b>AdapPrefPositiveStep: adaptive prefetch positive step.</b> Read-write. Reset: 00b. BIOS: 00b. Specifies the step size that the adaptive prefetch scheme uses when increasing the prefetch distance.<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>1/16</td></tr> <tr> <td>01b</td><td>2/16</td></tr> <tr> <td>10b</td><td>4/16</td></tr> <tr> <td>11b</td><td>8/16</td></tr> </table>                                                                                                                           | Bits | Description | 00b  | 1/16                                          | 01b       | 2/16             | 10b  | 4/16 | 11b | 8/16  |
| Bits      | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |      |             |      |                                               |           |                  |      |      |     |       |
| 00b       | 1/16                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |      |             |      |                                               |           |                  |      |      |     |       |
| 01b       | 2/16                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |      |             |      |                                               |           |                  |      |      |     |       |
| 10b       | 4/16                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |      |             |      |                                               |           |                  |      |      |     |       |
| 11b       | 8/16                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |      |             |      |                                               |           |                  |      |      |     |       |
| 1:0       | <b>AdapPrefMissRatio: adaptive prefetch miss ratio.</b> Read-write. Reset: 00b. BIOS: 01b. Specifies the ratio of prefetch requests that do not have data buffer available to the total number of prefetch requests at which the adaptive prefetch scheme begins decreasing the prefetch distance.<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>1/16</td></tr> <tr> <td>01b</td><td>2/16</td></tr> <tr> <td>10b</td><td>4/16</td></tr> <tr> <td>11b</td><td>8/16</td></tr> </table>                               | Bits | Description | 00b  | 1/16                                          | 01b       | 2/16             | 10b  | 4/16 | 11b | 8/16  |
| Bits      | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |      |             |      |                                               |           |                  |      |      |     |       |
| 00b       | 1/16                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |      |             |      |                                               |           |                  |      |      |     |       |
| 01b       | 2/16                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |      |             |      |                                               |           |                  |      |      |     |       |
| 10b       | 4/16                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |      |             |      |                                               |           |                  |      |      |     |       |
| 11b       | 8/16                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |      |             |      |                                               |           |                  |      |      |     |       |

**D18F2x1B4 Extended Memory Controller Configuration High Register**

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31    | <b>FlushOnMmioWrEn: flush on mmio write enable.</b> Read-write. Reset: 0. 1=Any CPU-sourced MMIO write that matches <a href="#">D18F1x[2CC:2A0,1CC:180,BC:80]</a> causes the memory controller data buffers to be flushed to memory.                                                                                                                                                                                                                                                                                                                                                                                                   |
| 30:28 | <b>S3SmafId: S3 SMAF id.</b> Read-write. Reset: 100b. SMAF encoding of <a href="#">D18F3x[84:80]</a> corresponding to the ACPI S3 state when FlushWrOnS3StpGnt=1. Reserved when FlushWrOnS3StpGnt=0.                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 27    | <b>FlushWrOnS3StpGnt: flush write on S3 stop grant.</b> Read-write. Reset: 0. BIOS: 1. 1=Write bursting is canceled and all outstanding writes are flushed to DRAM when in the stop-grant state and the SMAF code is equal to S3SmafId, indicating entry into the ACPI S3 state. See <a href="#">D18F2xA8_dct[3:0][FastSelfRefEntryDis]</a> , <a href="#">D18F2x11C[FlushWrOnStpGnt]</a> .                                                                                                                                                                                                                                             |
| 26    | <b>EnSplitMctDatBuffers: enable split MCT data buffers.</b> Read-write. Reset: 0. BIOS: 1. 1=Enable resource allocation into the split buffer resources BIOS must program this bit before any DRAM memory accesses are issued from the processor.                                                                                                                                                                                                                                                                                                                                                                                      |
| 25    | <b>SmuCfgLock: SMU configuration lock.</b> Read-write; updated-by-hardware. Reset: 0. This field should never be cleared by software. The following registers are read-only if LockSmuCfg=1; otherwise the access type is specified by the register: <ul style="list-style-type: none"> <li>• <a href="#">D18F4x15C [Core Performance Boost Control]</a></li> <li>• <a href="#">D18F5x12C [Clock Power/Timing Control 4]</a></li> <li>• <a href="#">D18F5x170 [Northbridge P-state Control]</a></li> <li>• <a href="#">D18F5x188 [Clock Power/Timing Control 5]</a></li> </ul> <a href="#">D18F5x170 [Northbridge P-state Control]</a> |
| 24:23 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| 22    | <b>SpecPrefDisWm1: speculative prefetch disable watermark 1.</b> Read-write. Reset: 0. 0=Disable speculative prefetches at the DcqBwThrotWm2 limit. 1=Disable speculative prefetches at the DcqBwThrotWm1 limit. See also <a href="#">D18F2x1B0[SpecPrefDis]</a> .                                                                                                                                                                                                                                                                                                                                                                     |
| 21    | <b>RegionAlloWm2: region prefetch allocate watermark 2.</b> Read-write. Reset: 0. See DemandAlloWm2.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 20    | <b>RegionPropWm2: region prefetch propagate watermark 2.</b> Read-write. Reset: 0. See DemandPropWm2.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 19    | <b>StrideAlloWm2: stride prefetch allocate watermark 2.</b> Read-write. Reset: 1. See DemandAlloWm2.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 18    | <b>StridePropWm2: stride prefetch propagate watermark 2.</b> Read-write. Reset: 1. See DemandPropWm2.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 17    | <b>DemandAlloWm2: demand request allocate watermark 2.</b> Read-write. Reset: 1. Specifies the behavior from the DcqBwThrotWm1 limit to the DcqBwThrotWm2 limit. 0=Requests do not allocate a new entry. 1=Requests allocate a new entry; defined only if (DemandAlloWm1 & DemandPropWm2).                                                                                                                                                                                                                                                                                                                                             |
| 16    | <b>DemandPropWm2: demand request propagate watermark 2.</b> Read-write. Reset: 1. Specifies the behavior from the DcqBwThrotWm1 limit to the DcqBwThrotWm2 limit. 0=Requests do not update existing entries. 1=Requests update existing entries; defined only if (DemandPropWm1=1).                                                                                                                                                                                                                                                                                                                                                    |
| 15    | <b>RegionAlloWm1: region prefetch allocate watermark 1.</b> Read-write. Reset: 0. See DemandAlloWm1.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |

|     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|-----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 14  | <b>RegionPropWm1: region prefetch propagate watermark 1.</b> Read-write. Reset: 1. See DemandPropWm1.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 13  | <b>StrideAlloWm1: stride prefetch allocate watermark 1.</b> Read-write. Reset: 1. See DemandAlloWm1.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| 12  | <b>StridePropWm1: stride prefetch propagate watermark 1.</b> Read-write. Reset: 1. See DemandPropWm1.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 11  | <b>DemandAlloWm1: demand request allocate watermark 1.</b> Read-write. Reset: 1. Specifies the behavior prior to the DcqBwThrotWm1 limit. 0=Requests do not allocate a new entry. 1=Requests allocate a new entry; defined only if (DemandPropWm1=1).                                                                                                                                                                                                                                                                                                                                                                                               |
| 10  | <b>DemandPropWm1: demand request propagate watermark 1.</b> Read-write. Reset: 1. Specifies the behavior prior to the DcqBwThrotWm1 limit. 0=Requests do not update existing entries. 1=Requests update existing entries.                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 9:5 | <b>DcqBwThrotWm2: DCQ bandwidth throttle watermark 2.</b> Read-write. Reset: 06h. BIOS: <a href="#">Table 180</a> . Specifies a prefetch throttling watermark based on the number of outstanding DRAM read requests. This field is reserved when <a href="#">D18F2x1B0[DcqBwThrotWm]</a> != 0. When throttling is enabled, if the number of outstanding DRAM read requests exceeds DcqBwThrotWm2 both request allocate and propagate are blocked and new prefetches are disabled. When throttling is enabled, DcqBwThrotWm2 should be programmed to a value greater than DcqBwThrotWm1. 0h=Throttling is disabled. Legal values are 0h through 18h. |
| 4:0 | <b>DcqBwThrotWm1: DCQ bandwidth throttle watermark 1.</b> Read-write. Reset: 03h. BIOS: <a href="#">Table 180</a> . Specifies a prefetch throttling watermark based on the number of outstanding DRAM read requests. This field is reserved when <a href="#">D18F2x1B0[DcqBwThrotWm]</a> != 0. 0h=Throttling is disabled. Legal values are 0h through 18h.                                                                                                                                                                                                                                                                                          |

### D18F2x1BC\_dct[3:0] DRAM CKE to CS Map

Reset: 0000\_AA55h. See [2.9.3 \[DCT Configuration Registers\]](#).

Table 181: Field Mapping for [D18F2x1BC\\_dct\[3:0\]](#)

| Register                           | Bits  |       |      |      |
|------------------------------------|-------|-------|------|------|
|                                    | 31:24 | 23:16 | 15:8 | 7:0  |
| <a href="#">D18F2x1BC_dct[3:0]</a> | CKE3  | CKE2  | CKE1 | CKE0 |

Table 182: BIOS Recommendations for [D18F2x1BC\\_dct\[3:0\]](#)

|            |                              |                                    |
|------------|------------------------------|------------------------------------|
| Condition: |                              | <a href="#">D18F2x1BC_dct[3:0]</a> |
| Package    | <a href="#">NumDimmSlots</a> |                                    |
| FP3        | 1, 2                         | 08040201h                          |

| Bits  | Description                                                                 |
|-------|-----------------------------------------------------------------------------|
| 31:24 | <b>CSMapCKE: CS map CKE.</b> See: <a href="#">D18F2x1BC_dct[3:0][7:0]</a> . |
| 23:16 | <b>CSMapCKE: CS map CKE.</b> See: <a href="#">D18F2x1BC_dct[3:0][7:0]</a> . |

| 15:8       | <b>CSMapCKE: CS map CKE.</b> See: <a href="#">D18F2x1BC_dct[3:0][7:0]</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |            |                    |     |     |     |     |     |     |     |     |       |          |
|------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|--------------------|-----|-----|-----|-----|-----|-----|-----|-----|-------|----------|
| 7:0        | <p><b>CSMapCKE: CS map CKE.</b> Read-write. BIOS: See <a href="#">Table 182 [BIOS Recommendations for D18F2x1BC_dct[3:0]]</a>. Maps the CS to CKE relationship. 1=This CKE is associated with the listed chip select. 0=This CKE is not associated with the listed chip select.</p> <p>Only 1 CKE may be assigned to a CS across <a href="#">D18F2x1BC_dct[3:0]</a>. Only even CKEs may be assigned to even CSes. Only odd CKEs may be assigned to odd CSes.</p> <table> <tr> <th><u>Bit</u></th><th><u>Description</u></th></tr> <tr> <td>[0]</td><td>CS0</td></tr> <tr> <td>[1]</td><td>CS1</td></tr> <tr> <td>[2]</td><td>CS2</td></tr> <tr> <td>[3]</td><td>CS3</td></tr> <tr> <td>[7:4]</td><td>Reserved</td></tr> </table> | <u>Bit</u> | <u>Description</u> | [0] | CS0 | [1] | CS1 | [2] | CS2 | [3] | CS3 | [7:4] | Reserved |
| <u>Bit</u> | <u>Description</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |            |                    |     |     |     |     |     |     |     |     |       |          |
| [0]        | CS0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |            |                    |     |     |     |     |     |     |     |     |       |          |
| [1]        | CS1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |            |                    |     |     |     |     |     |     |     |     |       |          |
| [2]        | CS2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |            |                    |     |     |     |     |     |     |     |     |       |          |
| [3]        | CS3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |            |                    |     |     |     |     |     |     |     |     |       |          |
| [7:4]      | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |            |                    |     |     |     |     |     |     |     |     |       |          |

### D18F2x200\_dct[3:0]\_mp[1:0] DDR3 DRAM Timing 0

Reset: 0F05\_0505h. See [2.9.3 \[DCT Configuration Registers\]](#).

| Bits        | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |             |                    |         |          |         |               |         |          |
|-------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|--------------------|---------|----------|---------|---------------|---------|----------|
| 31:30       | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |             |                    |         |          |         |               |         |          |
| 29:24       | <p><b>Tras: row active strobe.</b> Read-write. BIOS: See <a href="#">2.9.9.3 [SPD ROM-Based Configuration]</a>. Specifies the minimum time in memory clock cycles from an activate command to a precharge command, both to the same chip select bank.</p> <table> <tr> <th><u>Bits</u></th><th><u>Description</u></th></tr> <tr> <td>07h-00h</td><td>Reserved</td></tr> <tr> <td>2Ah-08h</td><td>&lt;Tras&gt; clocks</td></tr> <tr> <td>3Fh-2Bh</td><td>Reserved</td></tr> </table>            | <u>Bits</u> | <u>Description</u> | 07h-00h | Reserved | 2Ah-08h | <Tras> clocks | 3Fh-2Bh | Reserved |
| <u>Bits</u> | <u>Description</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |             |                    |         |          |         |               |         |          |
| 07h-00h     | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |             |                    |         |          |         |               |         |          |
| 2Ah-08h     | <Tras> clocks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |             |                    |         |          |         |               |         |          |
| 3Fh-2Bh     | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |             |                    |         |          |         |               |         |          |
| 23:21       | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |             |                    |         |          |         |               |         |          |
| 20:16       | <p><b>Trp: row precharge time.</b> Read-write. BIOS: See <a href="#">2.9.9.3 [SPD ROM-Based Configuration]</a>. Specifies the minimum time in memory clock cycles from a precharge command to an activate command or auto refresh command, both to the same bank.</p> <table> <tr> <th><u>Bits</u></th><th><u>Description</u></th></tr> <tr> <td>04h-00h</td><td>Reserved</td></tr> <tr> <td>13h-05h</td><td>&lt;Trp&gt; clocks</td></tr> <tr> <td>1Fh-14h</td><td>Reserved</td></tr> </table> | <u>Bits</u> | <u>Description</u> | 04h-00h | Reserved | 13h-05h | <Trp> clocks  | 1Fh-14h | Reserved |
| <u>Bits</u> | <u>Description</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |             |                    |         |          |         |               |         |          |
| 04h-00h     | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |             |                    |         |          |         |               |         |          |
| 13h-05h     | <Trp> clocks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |             |                    |         |          |         |               |         |          |
| 1Fh-14h     | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |             |                    |         |          |         |               |         |          |
| 15:13       | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |             |                    |         |          |         |               |         |          |
| 12:8        | <p><b>Trcd: RAS to CAS delay.</b> Read-write. BIOS: See <a href="#">2.9.9.3 [SPD ROM-Based Configuration]</a>. Specifies the time in memory clock cycles from an activate command to a read/write command, both to the same bank.</p> <table> <tr> <th><u>Bits</u></th><th><u>Description</u></th></tr> <tr> <td>04h-00h</td><td>Reserved</td></tr> <tr> <td>13h-05h</td><td>&lt;Trcd&gt; clocks</td></tr> <tr> <td>1Fh-14h</td><td>Reserved</td></tr> </table>                                | <u>Bits</u> | <u>Description</u> | 04h-00h | Reserved | 13h-05h | <Trcd> clocks | 1Fh-14h | Reserved |
| <u>Bits</u> | <u>Description</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |             |                    |         |          |         |               |         |          |
| 04h-00h     | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |             |                    |         |          |         |               |         |          |
| 13h-05h     | <Trcd> clocks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |             |                    |         |          |         |               |         |          |
| 1Fh-14h     | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |             |                    |         |          |         |               |         |          |



| 7:5     | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                               |      |             |         |          |         |              |         |          |
|---------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|---------|----------|---------|--------------|---------|----------|
| 4:0     | <p><b>Tcl: CAS latency.</b> Read-write. BIOS: See <a href="#">2.9.9.3 [SPD ROM-Based Configuration]</a>. Specifies the time in memory clock cycles from the CAS assertion for a read cycle until data return (from the perspective of the DRAM devices).</p> <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>04h-00h</td><td>Reserved</td></tr> <tr> <td>13h-05h</td><td>&lt;Tcl&gt; clocks</td></tr> <tr> <td>1Fh-14h</td><td>Reserved</td></tr> </table> | Bits | Description | 04h-00h | Reserved | 13h-05h | <Tcl> clocks | 1Fh-14h | Reserved |
| Bits    | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                             |      |             |         |          |         |              |         |          |
| 04h-00h | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                |      |             |         |          |         |              |         |          |
| 13h-05h | <Tcl> clocks                                                                                                                                                                                                                                                                                                                                                                                                                                                            |      |             |         |          |         |              |         |          |
| 1Fh-14h | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                |      |             |         |          |         |              |         |          |

### D18F2x204\_dct[3:0]\_mp[1:0] DDR3 DRAM Timing 1

Reset: 0400\_040Bh. See [2.9.3 \[DCT Configuration Registers\]](#).

| Bits    | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |      |             |         |                            |         |               |         |                        |         |          |
|---------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|---------|----------------------------|---------|---------------|---------|------------------------|---------|----------|
| 31:28   | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |      |             |         |                            |         |               |         |                        |         |          |
| 27:24   | <p><b>Trtp: read CAS to precharge time.</b> Read-write. BIOS: See <a href="#">2.9.9.3</a>. Specifies the earliest time in memory clock cycles a page can be closed after having been read. Satisfying this parameter ensures read data is not lost due to a premature precharge.</p> <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>3h-0h</td><td>Reserved</td></tr> <tr> <td>Bh-4h</td><td>&lt;Trtp&gt; clocks</td></tr> <tr> <td>Fh-Ch</td><td>Reserved</td></tr> </table>                    | Bits | Description | 3h-0h   | Reserved                   | Bh-4h   | <Trtp> clocks | Fh-Ch   | Reserved               |         |          |
| Bits    | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |      |             |         |                            |         |               |         |                        |         |          |
| 3h-0h   | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |      |             |         |                            |         |               |         |                        |         |          |
| Bh-4h   | <Trtp> clocks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |      |             |         |                            |         |               |         |                        |         |          |
| Fh-Ch   | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |      |             |         |                            |         |               |         |                        |         |          |
| 23:22   | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |      |             |         |                            |         |               |         |                        |         |          |
| 21:16   | <p><b>FourActWindow: four bank activate window.</b> Read-write. BIOS: See <a href="#">2.9.9.3</a>. Specifies the rolling tFAW window in memory clock cycles during which no more than 4 banks in an 8-bank device are activated.</p> <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00h</td><td>No tFAW window restriction</td></tr> <tr> <td>05h-01h</td><td>Reserved</td></tr> <tr> <td>2Ch-06h</td><td>[FourActWindow] clocks</td></tr> <tr> <td>3Fh-2Dh</td><td>Reserved</td></tr> </table> | Bits | Description | 00h     | No tFAW window restriction | 05h-01h | Reserved      | 2Ch-06h | [FourActWindow] clocks | 3Fh-2Dh | Reserved |
| Bits    | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |      |             |         |                            |         |               |         |                        |         |          |
| 00h     | No tFAW window restriction                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |      |             |         |                            |         |               |         |                        |         |          |
| 05h-01h | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |      |             |         |                            |         |               |         |                        |         |          |
| 2Ch-06h | [FourActWindow] clocks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |      |             |         |                            |         |               |         |                        |         |          |
| 3Fh-2Dh | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |      |             |         |                            |         |               |         |                        |         |          |
| 15:12   | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |      |             |         |                            |         |               |         |                        |         |          |
| 11:8    | <p><b>Trrd: row to row delay (or RAS to RAS delay).</b> Read-write. BIOS: See <a href="#">2.9.9.3</a>. Specifies the minimum time in memory clock cycles between activate commands to different chip select banks.</p> <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>0h</td><td>Reserved</td></tr> <tr> <td>9h-1h</td><td>&lt;Trrd&gt; clocks</td></tr> <tr> <td>Fh-Ah</td><td>Reserved</td></tr> </table>                                                                                     | Bits | Description | 0h      | Reserved                   | 9h-1h   | <Trrd> clocks | Fh-Ah   | Reserved               |         |          |
| Bits    | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |      |             |         |                            |         |               |         |                        |         |          |
| 0h      | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |      |             |         |                            |         |               |         |                        |         |          |
| 9h-1h   | <Trrd> clocks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |      |             |         |                            |         |               |         |                        |         |          |
| Fh-Ah   | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |      |             |         |                            |         |               |         |                        |         |          |
| 7:6     | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |      |             |         |                            |         |               |         |                        |         |          |
| 5:0     | <p><b>Trc: row cycle time.</b> Read-write. BIOS: See <a href="#">2.9.9.3</a>. Specifies the minimum time in memory clock cycles from and activate command to another activate command or an auto refresh command, all to the same chip select bank.</p> <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>09h-00h</td><td>Reserved</td></tr> <tr> <td>3Ah-0Ah</td><td>&lt;Trc&gt; clocks</td></tr> <tr> <td>3Fh-3Bh</td><td>Reserved</td></tr> </table>                                            | Bits | Description | 09h-00h | Reserved                   | 3Ah-0Ah | <Trc> clocks  | 3Fh-3Bh | Reserved               |         |          |
| Bits    | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |      |             |         |                            |         |               |         |                        |         |          |
| 09h-00h | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |      |             |         |                            |         |               |         |                        |         |          |
| 3Ah-0Ah | <Trc> clocks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |      |             |         |                            |         |               |         |                        |         |          |
| 3Fh-3Bh | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |      |             |         |                            |         |               |         |                        |         |          |



**D18F2x208\_dct[3:0] DDR3 DRAM Timing 2**

See 2.9.3 [DCT Configuration Registers].

| Bits      | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |      |             |      |          |      |       |      |        |      |        |      |        |      |        |           |          |
|-----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|------|----------|------|-------|------|--------|------|--------|------|--------|------|--------|-----------|----------|
| 31:27     | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |      |             |      |          |      |       |      |        |      |        |      |        |      |        |           |          |
| 26:24     | <b>Trfc3: auto refresh row cycle time for CS 6 and 7.</b> See: Trfc0.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |      |             |      |          |      |       |      |        |      |        |      |        |      |        |           |          |
| 23:19     | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |      |             |      |          |      |       |      |        |      |        |      |        |      |        |           |          |
| 18:16     | <b>Trfc2: auto refresh row cycle time for CS 4 and 5.</b> See: Trfc0.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |      |             |      |          |      |       |      |        |      |        |      |        |      |        |           |          |
| 15:11     | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |      |             |      |          |      |       |      |        |      |        |      |        |      |        |           |          |
| 10:8      | <b>Trfc1: auto refresh row cycle time for CS 2 and 3.</b> See: Trfc0.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |      |             |      |          |      |       |      |        |      |        |      |        |      |        |           |          |
| 7:3       | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |      |             |      |          |      |       |      |        |      |        |      |        |      |        |           |          |
| 2:0       | <b>Trfc0: auto refresh row cycle time for CS 0 and 1.</b> Read-write. Reset: 100b. BIOS: 2.9.9.3. Specifies the minimum time from a refresh command to the next valid command, except NOP or DES. The recommended programming of this register varies based on DRAM density and speed. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>000b</td><td>Reserved</td></tr> <tr> <td>001b</td><td>90 ns</td></tr> <tr> <td>010b</td><td>110 ns</td></tr> <tr> <td>011b</td><td>160 ns</td></tr> <tr> <td>100b</td><td>300 ns</td></tr> <tr> <td>101b</td><td>350 ns</td></tr> <tr> <td>111b-110b</td><td>Reserved</td></tr> </table> | Bits | Description | 000b | Reserved | 001b | 90 ns | 010b | 110 ns | 011b | 160 ns | 100b | 300 ns | 101b | 350 ns | 111b-110b | Reserved |
| Bits      | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |      |             |      |          |      |       |      |        |      |        |      |        |      |        |           |          |
| 000b      | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |      |             |      |          |      |       |      |        |      |        |      |        |      |        |           |          |
| 001b      | 90 ns                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |      |             |      |          |      |       |      |        |      |        |      |        |      |        |           |          |
| 010b      | 110 ns                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |      |             |      |          |      |       |      |        |      |        |      |        |      |        |           |          |
| 011b      | 160 ns                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |      |             |      |          |      |       |      |        |      |        |      |        |      |        |           |          |
| 100b      | 300 ns                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |      |             |      |          |      |       |      |        |      |        |      |        |      |        |           |          |
| 101b      | 350 ns                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |      |             |      |          |      |       |      |        |      |        |      |        |      |        |           |          |
| 111b-110b | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |      |             |      |          |      |       |      |        |      |        |      |        |      |        |           |          |

**D18F2x20C\_dct[3:0]\_mp[1:0] DDR3 DRAM Timing 3**

See 2.9.3 [DCT Configuration Registers].

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |      |             |       |                |       |                  |       |          |     |          |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|-------|----------------|-------|------------------|-------|----------|-----|----------|
| 31:18 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |      |             |       |                |       |                  |       |          |     |          |
| 17:16 | <b>WrDqDqsEarly: DQ and DQS write early.</b> Read-write. Reset: 0. Specifies the DQ and DQS launch timing for write commands relative to the Tcwl MEMCLK. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>0 MEMCLK early</td></tr> <tr> <td>01b</td><td>0.5 MEMCLK early</td></tr> <tr> <td>10b</td><td>Reserved</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>                                                                                                                                                                                    | Bits | Description | 00b   | 0 MEMCLK early | 01b   | 0.5 MEMCLK early | 10b   | Reserved | 11b | Reserved |
| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |      |             |       |                |       |                  |       |          |     |          |
| 00b   | 0 MEMCLK early                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |      |             |       |                |       |                  |       |          |     |          |
| 01b   | 0.5 MEMCLK early                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |      |             |       |                |       |                  |       |          |     |          |
| 10b   | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |      |             |       |                |       |                  |       |          |     |          |
| 11b   | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |      |             |       |                |       |                  |       |          |     |          |
| 15:12 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |      |             |       |                |       |                  |       |          |     |          |
| 11:8  | <b>Twtr: internal DRAM write to read command delay.</b> Read-write. Reset: 4h. BIOS: See 2.9.9.3. Specifies the minimum number of memory clock cycles from a write operation to a read operation, both to the same chip select. This is measured from the rising clock edge following last non-masked data strobe of the write to the rising clock edge of the next read command. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>3h-0h</td><td>Reserved</td></tr> <tr> <td>Bh-4h</td><td>&lt;Twtr&gt; clocks</td></tr> <tr> <td>Fh-Ch</td><td>Reserved</td></tr> </table> | Bits | Description | 3h-0h | Reserved       | Bh-4h | <Twtr> clocks    | Fh-Ch | Reserved |     |          |
| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |      |             |       |                |       |                  |       |          |     |          |
| 3h-0h | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |      |             |       |                |       |                  |       |          |     |          |
| Bh-4h | <Twtr> clocks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |      |             |       |                |       |                  |       |          |     |          |
| Fh-Ch | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |      |             |       |                |       |                  |       |          |     |          |

| 7:5     | Reserved.                                                                                                                                                                                                                                                                                                                                                                                            |      |             |         |          |         |               |         |          |
|---------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|---------|----------|---------|---------------|---------|----------|
| 4:0     | <b>Tcwl: CAS write latency.</b> Read-write. Reset: 5h. BIOS: See 2.9.9.3. Specifies the number of memory clock cycles from internal write command to first write data in at the DRAM.<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>04h-00h</td><td>Reserved</td></tr> <tr> <td>0Ah-05h</td><td>&lt;Tcwl&gt; clocks</td></tr> <tr> <td>1Fh-0Bh</td><td>Reserved</td></tr> </table> | Bits | Description | 04h-00h | Reserved | 0Ah-05h | <Tcwl> clocks | 1Fh-0Bh | Reserved |
| Bits    | Description                                                                                                                                                                                                                                                                                                                                                                                          |      |             |         |          |         |               |         |          |
| 04h-00h | Reserved                                                                                                                                                                                                                                                                                                                                                                                             |      |             |         |          |         |               |         |          |
| 0Ah-05h | <Tcwl> clocks                                                                                                                                                                                                                                                                                                                                                                                        |      |             |         |          |         |               |         |          |
| 1Fh-0Bh | Reserved                                                                                                                                                                                                                                                                                                                                                                                             |      |             |         |          |         |               |         |          |

#### D18F2x210\_dct[3:0]\_nbp[3:0] DRAM NB P-state

See 2.9.3 [DCT Configuration Registers]. For D18F2x210\_dct[3:0]\_nbp[x], x=D18F1x10C[NbPsSel]; see D18F1x10C[NbPsSel].

| Bits      | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |      |             |      |          |           |                      |      |            |      |             |      |             |      |             |      |             |      |          |
|-----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|------|----------|-----------|----------------------|------|------------|------|-------------|------|-------------|------|-------------|------|-------------|------|----------|
| 31:22     | <b>MaxRdLatency: maximum read latency.</b> Read-write. Reset: 000h. BIOS: See 2.9.9.6 [DRAM Training]. Specifies the maximum round-trip latency in the system from the processor to the DRAM devices and back. The DRAM controller uses this to help determine when the first two beats of incoming DRAM read data can be safely transferred to the NCLK domain. The time includes the asynchronous and synchronous latencies.<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>000h</td><td>0 NCLKs</td></tr> <tr> <td>3FEh-001h</td><td>&lt;MaxRdLatency&gt; NCLKs</td></tr> <tr> <td>3FFh</td><td>1023 NCLKs</td></tr> </table> | Bits | Description | 000h | 0 NCLKs  | 3FEh-001h | <MaxRdLatency> NCLKs | 3FFh | 1023 NCLKs |      |             |      |             |      |             |      |             |      |          |
| Bits      | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |      |             |      |          |           |                      |      |            |      |             |      |             |      |             |      |             |      |          |
| 000h      | 0 NCLKs                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |      |             |      |          |           |                      |      |            |      |             |      |             |      |             |      |             |      |          |
| 3FEh-001h | <MaxRdLatency> NCLKs                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |      |             |      |          |           |                      |      |            |      |             |      |             |      |             |      |             |      |          |
| 3FFh      | 1023 NCLKs                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |      |             |      |          |           |                      |      |            |      |             |      |             |      |             |      |             |      |          |
| 21:19     | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |      |             |      |          |           |                      |      |            |      |             |      |             |      |             |      |             |      |          |
| 18:16     | <b>DataTxFifoWrDly: data transmit FIFO write delay.</b> Read-write. Reset: 0. BIOS: 0h. Specifies the DCT to phy write data FIFO delay.<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>000b</td><td>0 MEMCLK</td></tr> <tr> <td>001b</td><td>0.5 MEMCLK</td></tr> <tr> <td>010b</td><td>1.0 MEMCLK</td></tr> <tr> <td>011b</td><td>1.5 MEMCLKs</td></tr> <tr> <td>100b</td><td>2.0 MEMCLKs</td></tr> <tr> <td>101b</td><td>2.5 MEMCLKs</td></tr> <tr> <td>110b</td><td>3.0 MEMCLKs</td></tr> <tr> <td>111b</td><td>Reserved</td></tr> </table>                                                                                   | Bits | Description | 000b | 0 MEMCLK | 001b      | 0.5 MEMCLK           | 010b | 1.0 MEMCLK | 011b | 1.5 MEMCLKs | 100b | 2.0 MEMCLKs | 101b | 2.5 MEMCLKs | 110b | 3.0 MEMCLKs | 111b | Reserved |
| Bits      | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |      |             |      |          |           |                      |      |            |      |             |      |             |      |             |      |             |      |          |
| 000b      | 0 MEMCLK                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |      |             |      |          |           |                      |      |            |      |             |      |             |      |             |      |             |      |          |
| 001b      | 0.5 MEMCLK                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |      |             |      |          |           |                      |      |            |      |             |      |             |      |             |      |             |      |          |
| 010b      | 1.0 MEMCLK                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |      |             |      |          |           |                      |      |            |      |             |      |             |      |             |      |             |      |          |
| 011b      | 1.5 MEMCLKs                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |      |             |      |          |           |                      |      |            |      |             |      |             |      |             |      |             |      |          |
| 100b      | 2.0 MEMCLKs                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |      |             |      |          |           |                      |      |            |      |             |      |             |      |             |      |             |      |          |
| 101b      | 2.5 MEMCLKs                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |      |             |      |          |           |                      |      |            |      |             |      |             |      |             |      |             |      |          |
| 110b      | 3.0 MEMCLKs                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |      |             |      |          |           |                      |      |            |      |             |      |             |      |             |      |             |      |          |
| 111b      | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |      |             |      |          |           |                      |      |            |      |             |      |             |      |             |      |             |      |          |
| 15:0      | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |      |             |      |          |           |                      |      |            |      |             |      |             |      |             |      |             |      |          |

#### D18F2x214\_dct[3:0]\_mp[1:0] DDR3 DRAM Timing 4

Reset: 0001\_0202h.

| Bits  | Description |
|-------|-------------|
| 31:20 | Reserved.   |

| 19:16       | <p><b>TwrrwrSdSc: write to write timing same DIMM same chip select.</b> Read-write. BIOS: See <a href="#">2.9.9.4.1.2 [TwrrwrSdSc, TwrrwrSdDc, TwrrwrDd (Wr-&gt;Wr Timing)]</a>. Specifies the minimum number of cycles from the last clock of virtual CAS of the first write-burst operation to the clock in which CAS is asserted for a following write-burst operation.</p> <table> <tr> <th><u>Bits</u></th><th><u>Description</u></th></tr> <tr> <td>0h</td><td>Reserved</td></tr> <tr> <td>1h</td><td>1 clock</td></tr> <tr> <td>Ah-2h</td><td>&lt;TwrrwrSdSc&gt; clocks</td></tr> <tr> <td>Bh</td><td>11 clocks</td></tr> <tr> <td>Fh-Ch</td><td>Reserved</td></tr> </table> | <u>Bits</u> | <u>Description</u> | 0h    | Reserved | 1h    | 1 clock           | Ah-2h | <TwrrwrSdSc> clocks | Bh | 11 clocks | Fh-Ch | Reserved |
|-------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|--------------------|-------|----------|-------|-------------------|-------|---------------------|----|-----------|-------|----------|
| <u>Bits</u> | <u>Description</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |             |                    |       |          |       |                   |       |                     |    |           |       |          |
| 0h          | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |             |                    |       |          |       |                   |       |                     |    |           |       |          |
| 1h          | 1 clock                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |             |                    |       |          |       |                   |       |                     |    |           |       |          |
| Ah-2h       | <TwrrwrSdSc> clocks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |             |                    |       |          |       |                   |       |                     |    |           |       |          |
| Bh          | 11 clocks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |             |                    |       |          |       |                   |       |                     |    |           |       |          |
| Fh-Ch       | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |             |                    |       |          |       |                   |       |                     |    |           |       |          |
| 15:12       | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |             |                    |       |          |       |                   |       |                     |    |           |       |          |
| 11:8        | <b>TwrrwrSdDc: write to write timing same DIMM different chip select.</b> See: TwrrwrDd.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |             |                    |       |          |       |                   |       |                     |    |           |       |          |
| 7:4         | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |             |                    |       |          |       |                   |       |                     |    |           |       |          |
| 3:0         | <p><b>TwrrwrDd: write to write timing different DIMM.</b> Read-write. BIOS: See <a href="#">2.9.9.4.1.2 [TwrrwrSdSc, TwrrwrSdDc, TwrrwrDd (Wr-&gt;Wr Timing)]</a>. Specifies the minimum number of cycles from the last clock of virtual CAS of the first write-burst operation to the clock in which CAS is asserted for a following write-burst operation.</p> <table> <tr> <th><u>Bits</u></th><th><u>Description</u></th></tr> <tr> <td>1h-0h</td><td>Reserved</td></tr> <tr> <td>Bh-2h</td><td>&lt;TwrrwrDd&gt; clocks</td></tr> <tr> <td>Fh-Ch</td><td>Reserved</td></tr> </table>                                                                                            | <u>Bits</u> | <u>Description</u> | 1h-0h | Reserved | Bh-2h | <TwrrwrDd> clocks | Fh-Ch | Reserved            |    |           |       |          |
| <u>Bits</u> | <u>Description</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |             |                    |       |          |       |                   |       |                     |    |           |       |          |
| 1h-0h       | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |             |                    |       |          |       |                   |       |                     |    |           |       |          |
| Bh-2h       | <TwrrwrDd> clocks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |             |                    |       |          |       |                   |       |                     |    |           |       |          |
| Fh-Ch       | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |             |                    |       |          |       |                   |       |                     |    |           |       |          |

### D18F2x218\_det[3:0]\_mp[1:0] DDR3 DRAM Timing 5

Reset: 0103\_0203h. See [2.9.3 \[DCT Configuration Registers\]](#).

| Bits        | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |             |                    |     |                                                                              |       |                                 |       |                                       |     |          |
|-------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|--------------------|-----|------------------------------------------------------------------------------|-------|---------------------------------|-------|---------------------------------------|-----|----------|
| 31:30       | <p><b>TrdrdBan: read to read timing ban.</b> Read-write. BIOS: See <a href="#">2.9.9.4.1</a>. Bans the traffic for the specified cases where the number of cycles from the last clock of virtual CAS of a first read-burst operation to the clock in which CAS is asserted for a following read-burst operation.</p> <table> <tr> <th><u>Bits</u></th><th><u>Description</u></th></tr> <tr> <td>00b</td><td>Ban disabled, traffic allowed as specified by TrdrdSdSc, TrdrdSdDc, TrdrdDd.</td></tr> <tr> <td>01b</td><td>Ban Trdrd traffic at 2 MEMCLKs.</td></tr> <tr> <td>10b</td><td>Ban Trdrd traffic at 2 and 3 MEMCLKs.</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table> | <u>Bits</u> | <u>Description</u> | 00b | Ban disabled, traffic allowed as specified by TrdrdSdSc, TrdrdSdDc, TrdrdDd. | 01b   | Ban Trdrd traffic at 2 MEMCLKs. | 10b   | Ban Trdrd traffic at 2 and 3 MEMCLKs. | 11b | Reserved |
| <u>Bits</u> | <u>Description</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |             |                    |     |                                                                              |       |                                 |       |                                       |     |          |
| 00b         | Ban disabled, traffic allowed as specified by TrdrdSdSc, TrdrdSdDc, TrdrdDd.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |             |                    |     |                                                                              |       |                                 |       |                                       |     |          |
| 01b         | Ban Trdrd traffic at 2 MEMCLKs.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |             |                    |     |                                                                              |       |                                 |       |                                       |     |          |
| 10b         | Ban Trdrd traffic at 2 and 3 MEMCLKs.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |             |                    |     |                                                                              |       |                                 |       |                                       |     |          |
| 11b         | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |             |                    |     |                                                                              |       |                                 |       |                                       |     |          |
| 29:28       | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |             |                    |     |                                                                              |       |                                 |       |                                       |     |          |
| 27:24       | <p><b>TrdrdSdSc: read to read timing same DIMM same chip select.</b> Read-write. BIOS: See <a href="#">2.9.9.4.1.1 [TrdrdBan, TrdrdSdSc, TrdrdSdDc, and TrdrdDd (Rd-&gt;Rd Timing)]</a>. Specifies the minimum number of cycles from the last clock of virtual CAS of a first read-burst operation to the clock in which CAS is asserted for a following read-burst operation.</p> <table> <tr> <th><u>Bits</u></th><th><u>Description</u></th></tr> <tr> <td>0h</td><td>Reserved</td></tr> <tr> <td>Bh-1h</td><td>&lt;TrdrdSdSc&gt; clocks</td></tr> <tr> <td>Fh-Ch</td><td>Reserved</td></tr> </table>                                                                                | <u>Bits</u> | <u>Description</u> | 0h  | Reserved                                                                     | Bh-1h | <TrdrdSdSc> clocks              | Fh-Ch | Reserved                              |     |          |
| <u>Bits</u> | <u>Description</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |             |                    |     |                                                                              |       |                                 |       |                                       |     |          |
| 0h          | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |             |                    |     |                                                                              |       |                                 |       |                                       |     |          |
| Bh-1h       | <TrdrdSdSc> clocks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |             |                    |     |                                                                              |       |                                 |       |                                       |     |          |
| Fh-Ch       | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |             |                    |     |                                                                              |       |                                 |       |                                       |     |          |
| 23:20       | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |             |                    |     |                                                                              |       |                                 |       |                                       |     |          |

| 19:16 | <b>TrdrdSdDc: read to read timing same DIMM different chip select.</b> See: TrdrdDd.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |      |             |       |          |       |                  |       |          |
|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|-------|----------|-------|------------------|-------|----------|
| 15:12 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |      |             |       |          |       |                  |       |          |
| 11:8  | <p><b>Twrrd: write to read DIMM termination turnaround.</b> Read-write. BIOS: See <a href="#">2.9.9.4.1.3 [Twrrd (Write to Read DIMM Termination Turn-around)]</a>. Specifies the minimum number of cycles from the last clock of virtual CAS of the first write-burst operation to the clock in which CAS is asserted for a following read-burst operation, both to different chip selects.</p> <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>0h</td><td>Reserved</td></tr> <tr> <td>Bh-1h</td><td>&lt;Twrrd&gt; clocks</td></tr> <tr> <td>Fh-Ch</td><td>Reserved</td></tr> </table> | Bits | Description | 0h    | Reserved | Bh-1h | <Twrrd> clocks   | Fh-Ch | Reserved |
| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |      |             |       |          |       |                  |       |          |
| 0h    | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |      |             |       |          |       |                  |       |          |
| Bh-1h | <Twrrd> clocks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |      |             |       |          |       |                  |       |          |
| Fh-Ch | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |      |             |       |          |       |                  |       |          |
| 7:4   | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |      |             |       |          |       |                  |       |          |
| 3:0   | <p><b>TrdrdDd: read to read timing different DIMM.</b> Read-write. BIOS: See <a href="#">2.9.9.4.1.1 [TrdrdBan, TrdrdSdSc, TrdrdSdDc, and TrdrdDd (Rd-&gt;Rd Timing)]</a>. Specifies the minimum number of cycles from the last clock of virtual CAS of a first read-burst operation to the clock in which CAS is asserted for a following read-burst operation.</p> <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>1h-0h</td><td>Reserved</td></tr> <tr> <td>Bh-2h</td><td>&lt;TrdrdDd&gt; clocks</td></tr> <tr> <td>Fh-Ch</td><td>Reserved</td></tr> </table>                        | Bits | Description | 1h-0h | Reserved | Bh-2h | <TrdrdDd> clocks | Fh-Ch | Reserved |
| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |      |             |       |          |       |                  |       |          |
| 1h-0h | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |      |             |       |          |       |                  |       |          |
| Bh-2h | <TrdrdDd> clocks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |      |             |       |          |       |                  |       |          |
| Fh-Ch | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |      |             |       |          |       |                  |       |          |

#### D18F2x21C\_dct[3:0]\_mp[1:0] DDR3 DRAM Timing 6

Reset: 0004\_0300h. See [2.9.3 \[DCT Configuration Registers\]](#).

| Bits    | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |      |             |         |          |         |                 |         |          |
|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|---------|----------|---------|-----------------|---------|----------|
| 31:21   | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |      |             |         |          |         |                 |         |          |
| 20:16   | <p><b>TrwtWB: read to write turnaround for opportunistic write bursting.</b> Read-write. BIOS: TrwtTO + 1. Specifies the minimum number of clock cycles from the last clock of virtual CAS of a first read-burst operation to the clock in which CAS is asserted for a following write-burst operation.</p> <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>02h-00h</td><td>Reserved</td></tr> <tr> <td>1Ch-03h</td><td>&lt;TrwtWB&gt; clocks</td></tr> <tr> <td>1Fh-1Dh</td><td>Reserved</td></tr> </table>                                                  | Bits | Description | 02h-00h | Reserved | 1Ch-03h | <TrwtWB> clocks | 1Fh-1Dh | Reserved |
| Bits    | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |      |             |         |          |         |                 |         |          |
| 02h-00h | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |      |             |         |          |         |                 |         |          |
| 1Ch-03h | <TrwtWB> clocks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |      |             |         |          |         |                 |         |          |
| 1Fh-1Dh | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |      |             |         |          |         |                 |         |          |
| 15:13   | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |      |             |         |          |         |                 |         |          |
| 12:8    | <p><b>TrwtTO: read to write turnaround.</b> Read-write. BIOS: See <a href="#">2.9.9.4.1.4 [TrwtTO (Read-to-Write Turnaround for Data, DQS Contention)]</a>. Specifies the minimum number of clock cycles from the last clock of virtual CAS of a first read-burst operation to the clock in which CAS is asserted for a following write-burst operation.</p> <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>01h-00h</td><td>Reserved</td></tr> <tr> <td>1Bh-02h</td><td>&lt;TrwtTO&gt; clocks</td></tr> <tr> <td>1Fh-1Ch</td><td>Reserved</td></tr> </table> | Bits | Description | 01h-00h | Reserved | 1Bh-02h | <TrwtTO> clocks | 1Fh-1Ch | Reserved |
| Bits    | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |      |             |         |          |         |                 |         |          |
| 01h-00h | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |      |             |         |          |         |                 |         |          |
| 1Bh-02h | <TrwtTO> clocks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |      |             |         |          |         |                 |         |          |
| 1Fh-1Ch | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |      |             |         |          |         |                 |         |          |
| 7:0     | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |      |             |         |          |         |                 |         |          |

**D18F2x220\_dct[3:0] DDR3 DRAM Timing 7**Reset: 0000\_0C04h. See [2.9.3 \[DCT Configuration Registers\]](#).

| Bits    | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                  |      |             |       |          |        |               |         |          |
|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|-------|----------|--------|---------------|---------|----------|
| 31:13   | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                    |      |             |       |          |        |               |         |          |
| 12:8    | <b>Tmod: mode register command delay.</b> Read-write. BIOS: See <a href="#">2.9.9.3</a> . Specifies the minimum time in memory clock cycles from an MRS command to another non-MRS command (excluding NOP and DES), all to the same chip select.<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>1h-0h</td><td>Reserved</td></tr> <tr> <td>14h-2h</td><td>&lt;Tmod&gt; clocks</td></tr> <tr> <td>1Fh-15h</td><td>Reserved</td></tr> </table> | Bits | Description | 1h-0h | Reserved | 14h-2h | <Tmod> clocks | 1Fh-15h | Reserved |
| Bits    | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                  |      |             |       |          |        |               |         |          |
| 1h-0h   | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                     |      |             |       |          |        |               |         |          |
| 14h-2h  | <Tmod> clocks                                                                                                                                                                                                                                                                                                                                                                                                                                                |      |             |       |          |        |               |         |          |
| 1Fh-15h | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                     |      |             |       |          |        |               |         |          |
| 7:4     | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                    |      |             |       |          |        |               |         |          |
| 3:0     | <b>Tmrd: mode register command cycle time.</b> Read-write. BIOS: See <a href="#">2.9.9.3</a> . Specifies the minimum time in memory clock cycles from an MRS command to another MRS command, all to the same chip select.<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>1h-0h</td><td>Reserved</td></tr> <tr> <td>8h-2h</td><td>&lt;Tmrd&gt; clocks</td></tr> <tr> <td>Fh-9h</td><td>Reserved</td></tr> </table>                           | Bits | Description | 1h-0h | Reserved | 8h-2h  | <Tmrd> clocks | Fh-9h   | Reserved |
| Bits    | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                  |      |             |       |          |        |               |         |          |
| 1h-0h   | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                     |      |             |       |          |        |               |         |          |
| 8h-2h   | <Tmrd> clocks                                                                                                                                                                                                                                                                                                                                                                                                                                                |      |             |       |          |        |               |         |          |
| Fh-9h   | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                     |      |             |       |          |        |               |         |          |

**D18F2x224\_dct[3:0] DDR3 DRAM Timing 8**Reset: 0000\_0408h. See [2.9.3 \[DCT Configuration Registers\]](#).

| Bits        | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |             |                    |             |                    |      |          |      |           |      |           |      |           |      |           |      |           |      |           |      |          |
|-------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|--------------------|-------------|--------------------|------|----------|------|-----------|------|-----------|------|-----------|------|-----------|------|-----------|------|-----------|------|----------|
| 31:11       | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |             |                    |             |                    |      |          |      |           |      |           |      |           |      |           |      |           |      |           |      |          |
| 10:8        | <b>Tzqcs: Zq short cal command delay.</b> Read-write. BIOS: See 2.9.9.3. Specifies the minimum time in memory clock cycles from a ZQCS command to any other command (excluding NOP and DES) on the channel. <table><tr><th><u>Bits</u></th><th><u>Description</u></th><th><u>Bits</u></th><th><u>Description</u></th></tr><tr><td>000b</td><td>Reserved</td><td>100b</td><td>64 clocks</td></tr><tr><td>001b</td><td>16 clocks</td><td>101b</td><td>80 clocks</td></tr><tr><td>010b</td><td>32 clocks</td><td>110b</td><td>96 clocks</td></tr><tr><td>011b</td><td>48 clocks</td><td>111b</td><td>Reserved</td></tr></table> | <u>Bits</u> | <u>Description</u> | <u>Bits</u> | <u>Description</u> | 000b | Reserved | 100b | 64 clocks | 001b | 16 clocks | 101b | 80 clocks | 010b | 32 clocks | 110b | 96 clocks | 011b | 48 clocks | 111b | Reserved |
| <u>Bits</u> | <u>Description</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <u>Bits</u> | <u>Description</u> |             |                    |      |          |      |           |      |           |      |           |      |           |      |           |      |           |      |          |
| 000b        | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 100b        | 64 clocks          |             |                    |      |          |      |           |      |           |      |           |      |           |      |           |      |           |      |          |
| 001b        | 16 clocks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 101b        | 80 clocks          |             |                    |      |          |      |           |      |           |      |           |      |           |      |           |      |           |      |          |
| 010b        | 32 clocks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 110b        | 96 clocks          |             |                    |      |          |      |           |      |           |      |           |      |           |      |           |      |           |      |          |
| 011b        | 48 clocks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 111b        | Reserved           |             |                    |      |          |      |           |      |           |      |           |      |           |      |           |      |           |      |          |

|     |                                                                                                                                                                                                              |                    |             |                    |
|-----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|-------------|--------------------|
| 7:4 | Reserved.                                                                                                                                                                                                    |                    |             |                    |
| 3:0 | <b>Tzqoper: Zq long cal command delay.</b> Read-write. BIOS: See 2.9.9.3. Specifies the minimum time in memory clock cycles from a ZQCL command to any other command (excluding NOP and DES) on the channel. |                    |             |                    |
|     | <u>Bits</u>                                                                                                                                                                                                  | <u>Description</u> | <u>Bits</u> | <u>Description</u> |
|     | 0000b                                                                                                                                                                                                        | Reserved           | 1000b       | 256 clocks         |
|     | 0001b                                                                                                                                                                                                        | 32 clocks          | 1001b       | 288 clocks         |
|     | 0010b                                                                                                                                                                                                        | 64 clocks          | 1010b       | 320 clocks         |
|     | 0011b                                                                                                                                                                                                        | 96 clocks          | 1011b       | 352 clocks         |
|     | 0100b                                                                                                                                                                                                        | 128 clocks         | 1100b       | 384 clocks         |
|     | 0101b                                                                                                                                                                                                        | 160 clocks         | 1111b-1101b | Reserved           |
|     | 0110b                                                                                                                                                                                                        | 192 clocks         |             |                    |
|     | 0111b                                                                                                                                                                                                        | 224 clocks         |             |                    |

### D18F2x228\_dct[3:0] DDR3 DRAM Timing 9

See 2.9.3 [DCT Configuration Registers].

|             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |             |                    |     |          |         |                 |     |            |
|-------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|--------------------|-----|----------|---------|-----------------|-----|------------|
| Bits        | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |             |                    |     |          |         |                 |     |            |
| 31:24       | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |             |                    |     |          |         |                 |     |            |
| 23:16       | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |             |                    |     |          |         |                 |     |            |
| 15:8        | <b>Tstag1: auto refresh stagger time for logical DIMM 1.</b> See: Tstag0.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |             |                    |     |          |         |                 |     |            |
| 7:0         | <p><b>Tstag0: auto refresh stagger time for logical DIMM 0.</b> Read-write. Reset: 00h. BIOS: MAX(D18F2x204_dct[3:0]_mp[1:0][Trrd], CEIL(D18F2x204_dct[3:0]_mp[1:0][FourActWin-dow]/4)).</p> <p>Specifies the number of clocks between auto refresh commands to different ranks of a DIMM when D18F2x90_dct[3:0][StagRefEn]=1.</p> <table> <tr> <td><u>Bits</u></td><td><u>Description</u></td></tr> <tr> <td>00h</td><td>0 clocks</td></tr> <tr> <td>FEh-01h</td><td>&lt;Tstag0&gt; clocks</td></tr> <tr> <td>FFh</td><td>255 clocks</td></tr> </table> | <u>Bits</u> | <u>Description</u> | 00h | 0 clocks | FEh-01h | <Tstag0> clocks | FFh | 255 clocks |
| <u>Bits</u> | <u>Description</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |             |                    |     |          |         |                 |     |            |
| 00h         | 0 clocks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |             |                    |     |          |         |                 |     |            |
| FEh-01h     | <Tstag0> clocks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |             |                    |     |          |         |                 |     |            |
| FFh         | 255 clocks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |             |                    |     |          |         |                 |     |            |

### D18F2x22C\_dct[3:0]\_mp[1:0] DDR3 DRAM Timing 10

Reset: 0000\_000Ch. See 2.9.3 [DCT Configuration Registers].

|       |             |
|-------|-------------|
| Bits  | Description |
| 31:24 | Reserved.   |
| 23:13 | Reserved.   |
| 12:8  | Reserved.   |

| 7:5     | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |      |             |       |          |       |               |    |          |    |           |    |          |    |           |    |          |    |           |    |          |     |           |     |          |     |           |         |          |
|---------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|-------|----------|-------|---------------|----|----------|----|-----------|----|----------|----|-----------|----|----------|----|-----------|----|----------|-----|-----------|-----|----------|-----|-----------|---------|----------|
| 4:0     | <p><b>Twr: write recovery.</b> Read-write. BIOS: See <a href="#">2.9.9.3</a>. Specifies the minimum time from the last data write until the chip select bank precharge.</p> <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>4h-0h</td><td>Reserved</td></tr> <tr> <td>8h-5h</td><td>8 to 5 clocks</td></tr> <tr> <td>9h</td><td>Reserved</td></tr> <tr> <td>Ah</td><td>10 clocks</td></tr> <tr> <td>Bh</td><td>Reserved</td></tr> <tr> <td>Ch</td><td>12 clocks</td></tr> <tr> <td>Dh</td><td>Reserved</td></tr> <tr> <td>Eh</td><td>14 clocks</td></tr> <tr> <td>Fh</td><td>Reserved</td></tr> <tr> <td>10h</td><td>16 clocks</td></tr> <tr> <td>11h</td><td>Reserved</td></tr> <tr> <td>12h</td><td>18 clocks</td></tr> <tr> <td>1Fh-13h</td><td>Reserved</td></tr> </table> | Bits | Description | 4h-0h | Reserved | 8h-5h | 8 to 5 clocks | 9h | Reserved | Ah | 10 clocks | Bh | Reserved | Ch | 12 clocks | Dh | Reserved | Eh | 14 clocks | Fh | Reserved | 10h | 16 clocks | 11h | Reserved | 12h | 18 clocks | 1Fh-13h | Reserved |
| Bits    | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |      |             |       |          |       |               |    |          |    |           |    |          |    |           |    |          |    |           |    |          |     |           |     |          |     |           |         |          |
| 4h-0h   | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |      |             |       |          |       |               |    |          |    |           |    |          |    |           |    |          |    |           |    |          |     |           |     |          |     |           |         |          |
| 8h-5h   | 8 to 5 clocks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |      |             |       |          |       |               |    |          |    |           |    |          |    |           |    |          |    |           |    |          |     |           |     |          |     |           |         |          |
| 9h      | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |      |             |       |          |       |               |    |          |    |           |    |          |    |           |    |          |    |           |    |          |     |           |     |          |     |           |         |          |
| Ah      | 10 clocks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |      |             |       |          |       |               |    |          |    |           |    |          |    |           |    |          |    |           |    |          |     |           |     |          |     |           |         |          |
| Bh      | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |      |             |       |          |       |               |    |          |    |           |    |          |    |           |    |          |    |           |    |          |     |           |     |          |     |           |         |          |
| Ch      | 12 clocks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |      |             |       |          |       |               |    |          |    |           |    |          |    |           |    |          |    |           |    |          |     |           |     |          |     |           |         |          |
| Dh      | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |      |             |       |          |       |               |    |          |    |           |    |          |    |           |    |          |    |           |    |          |     |           |     |          |     |           |         |          |
| Eh      | 14 clocks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |      |             |       |          |       |               |    |          |    |           |    |          |    |           |    |          |    |           |    |          |     |           |     |          |     |           |         |          |
| Fh      | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |      |             |       |          |       |               |    |          |    |           |    |          |    |           |    |          |    |           |    |          |     |           |     |          |     |           |         |          |
| 10h     | 16 clocks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |      |             |       |          |       |               |    |          |    |           |    |          |    |           |    |          |    |           |    |          |     |           |     |          |     |           |         |          |
| 11h     | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |      |             |       |          |       |               |    |          |    |           |    |          |    |           |    |          |    |           |    |          |     |           |     |          |     |           |         |          |
| 12h     | 18 clocks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |      |             |       |          |       |               |    |          |    |           |    |          |    |           |    |          |    |           |    |          |     |           |     |          |     |           |         |          |
| 1Fh-13h | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |      |             |       |          |       |               |    |          |    |           |    |          |    |           |    |          |    |           |    |          |     |           |     |          |     |           |         |          |

#### **D18F2x[234:230]\_dct[3:0] DDR3 DRAM Read ODT Pattern [High:Low]**

Reset: 0000\_0000h. See [2.9.3 \[DCT Configuration Registers\]](#). This register is used by BIOS to specify the state of the ODT pins during DDR reads. F2x230 is used to control chip selects 0-3. F2x234 is used to control chip selects 4-7.

See [2.9.9.3.1 \[DRAM ODT Pin Control\]](#) for more information.

| Bits  | Description                                                                                                                                                |
|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:28 | Reserved.                                                                                                                                                  |
| 27:24 | <b>RdOdtPatCs73: read ODT pattern chip select [7,3].</b> See: RdOdtPatCs40.                                                                                |
| 23:20 | Reserved.                                                                                                                                                  |
| 19:16 | <b>RdOdtPatCs62: read ODT pattern chip select [6,2].</b> See: RdOdtPatCs40.                                                                                |
| 15:12 | Reserved.                                                                                                                                                  |
| 11:8  | <b>RdOdtPatCs51: read ODT pattern chip select [5,1].</b> See: RdOdtPatCs40.                                                                                |
| 7:4   | Reserved.                                                                                                                                                  |
| 3:0   | <b>RdOdtPatCs40: read ODT pattern chip select [4,0].</b> Read-write. Specifies the state of ODT[3:0] pins when a read occurs to the specified chip select. |

#### **D18F2x[23C:238]\_dct[3:0] DDR3 DRAM Write ODT Pattern [High:Low]**

Reset: 0000\_0000h. See [2.9.3 \[DCT Configuration Registers\]](#). This register is used by BIOS to specify the state of the ODT pins during DDR writes. F2x238 is used to control chip selects 0-3. F2x23C is used to control chip selects 4-7.

See [2.9.9.3.1 \[DRAM ODT Pin Control\]](#) for more information.

| Bits  | Description                                                                                                                                                   |
|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:28 | Reserved.                                                                                                                                                     |
| 27:24 | <b>WrOdtPatCs73: write ODT pattern chip select [7,3]</b> . See: WrOdtPatCs40.                                                                                 |
| 23:20 | Reserved.                                                                                                                                                     |
| 19:16 | <b>WrOdtPatCs62: write ODT pattern chip select [6,2]</b> . See: WrOdtPatCs40.                                                                                 |
| 15:12 | Reserved.                                                                                                                                                     |
| 11:8  | <b>WrOdtPatCs51: write ODT pattern chip select [5,1]</b> . See: WrOdtPatCs40.                                                                                 |
| 7:4   | Reserved.                                                                                                                                                     |
| 3:0   | <b>WrOdtPatCs40: write ODT pattern chip select [4,0]</b> . Read-write. Specifies the state of ODT[3:0] pins when a write occurs to the specified chip select. |

### D18F2x240\_dct[3:0]\_mp[1:0] DDR3 DRAM ODT Control

Reset: 0000\_0000h. See [2.9.3 \[DCT Configuration Registers\]](#).

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |      |             |       |          |       |                                                         |       |          |
|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|-------|----------|-------|---------------------------------------------------------|-------|----------|
| 31:15 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |      |             |       |          |       |                                                         |       |          |
| 14:12 | <b>WrOdtOnDuration: write ODT on duration.</b> Read-write. BIOS: 6. Specifies the number of memory clock cycles that ODT is asserted for writes.<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>5h-0h</td><td>Reserved</td></tr> <tr> <td>7h-6h</td><td>&lt;WrOdtOnDuration&gt; clocks</td></tr> </table>                                                                                                                                                            | Bits | Description | 5h-0h | Reserved | 7h-6h | <WrOdtOnDuration> clocks                                |       |          |
| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |      |             |       |          |       |                                                         |       |          |
| 5h-0h | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |      |             |       |          |       |                                                         |       |          |
| 7h-6h | <WrOdtOnDuration> clocks                                                                                                                                                                                                                                                                                                                                                                                                                                                              |      |             |       |          |       |                                                         |       |          |
| 11    | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |      |             |       |          |       |                                                         |       |          |
| 10:8  | <b>WrOdtTrnOnDly: Write ODT Turn On Delay.</b> Read-write. BIOS: 0. Specifies the number of memory clock cycles that ODT assertion is delayed relative to write CAS.<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>0h</td><td>0 clocks</td></tr> <tr> <td>7h-1h</td><td>&lt;WrOdtTrnOnDly&gt; clocks, Reserved if (WrOdtOnDuration=0)</td></tr> </table>                                                                                                            | Bits | Description | 0h    | 0 clocks | 7h-1h | <WrOdtTrnOnDly> clocks, Reserved if (WrOdtOnDuration=0) |       |          |
| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |      |             |       |          |       |                                                         |       |          |
| 0h    | 0 clocks                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |      |             |       |          |       |                                                         |       |          |
| 7h-1h | <WrOdtTrnOnDly> clocks, Reserved if (WrOdtOnDuration=0)                                                                                                                                                                                                                                                                                                                                                                                                                               |      |             |       |          |       |                                                         |       |          |
| 7:4   | <b>RdOdtOnDuration: Read ODT On Duration.</b> Read-write. BIOS: 6. Specifies the number of memory clock cycles that ODT is asserted for an eight-beat read burst. The controller will shorten the ODT pulse duration by two clock cycles if the burst is chopped.<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>5h-0h</td><td>Reserved</td></tr> <tr> <td>9h-6h</td><td>&lt;RdOdtOnDuration&gt; clocks</td></tr> <tr> <td>Fh-Ah</td><td>Reserved</td></tr> </table> | Bits | Description | 5h-0h | Reserved | 9h-6h | <RdOdtOnDuration> clocks                                | Fh-Ah | Reserved |
| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |      |             |       |          |       |                                                         |       |          |
| 5h-0h | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |      |             |       |          |       |                                                         |       |          |
| 9h-6h | <RdOdtOnDuration> clocks                                                                                                                                                                                                                                                                                                                                                                                                                                                              |      |             |       |          |       |                                                         |       |          |
| Fh-Ah | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |      |             |       |          |       |                                                         |       |          |
| 3:0   | <b>RdOdtTrnOnDly: Read ODT Turn On Delay.</b> Read-write. BIOS: MAX(0, <a href="#">D18F2x200_dct[3:0]_mp[1:0][Tcl]</a> - <a href="#">D18F2x20C_dct[3:0]_mp[1:0][Tcwl]</a> ). Specifies the number of clock cycles that ODT assertion is delayed relative to read CAS.<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>0h</td><td>0 clocks</td></tr> <tr> <td>Fh-0h</td><td>&lt;RdOdtTrnOnDly&gt; clocks, Reserved if (RdOdtOnDuration=0)</td></tr> </table>           | Bits | Description | 0h    | 0 clocks | Fh-0h | <RdOdtTrnOnDly> clocks, Reserved if (RdOdtOnDuration=0) |       |          |
| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |      |             |       |          |       |                                                         |       |          |
| 0h    | 0 clocks                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |      |             |       |          |       |                                                         |       |          |
| Fh-0h | <RdOdtTrnOnDly> clocks, Reserved if (RdOdtOnDuration=0)                                                                                                                                                                                                                                                                                                                                                                                                                               |      |             |       |          |       |                                                         |       |          |

### D18F2x244\_dct[3:0] DRAM Controller Miscellaneous 3

Reset: 0000\_0000h. See [2.9.3 \[DCT Configuration Registers\]](#).



| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |      |             |    |          |       |                            |    |            |       |          |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|----|----------|-------|----------------------------|----|------------|-------|----------|
| 31:8  | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |      |             |    |          |       |                            |    |            |       |          |
| 7:4   | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |      |             |    |          |       |                            |    |            |       |          |
| 3:0   | <b>PrtlChPDDynDly: partial channel power down dynamic delay.</b> Read-write. BIOS:4h. Specifies the channel idle hysteresis for fast exit/slow exit mode changes when <a href="#">D18F2xA8_dct[3:0][PrtlChP-DEnhEn]</a> =1.<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>0h</td><td>0 clocks</td></tr> <tr> <td>7h-1h</td><td>&lt;PrtlChPDDynDly*32&gt; clocks</td></tr> <tr> <td>8h</td><td>256 clocks</td></tr> <tr> <td>Fh-9h</td><td>Reserved</td></tr> </table> | Bits | Description | 0h | 0 clocks | 7h-1h | <PrtlChPDDynDly*32> clocks | 8h | 256 clocks | Fh-9h | Reserved |
| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |      |             |    |          |       |                            |    |            |       |          |
| 0h    | 0 clocks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |      |             |    |          |       |                            |    |            |       |          |
| 7h-1h | <PrtlChPDDynDly*32> clocks                                                                                                                                                                                                                                                                                                                                                                                                                                                              |      |             |    |          |       |                            |    |            |       |          |
| 8h    | 256 clocks                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |      |             |    |          |       |                            |    |            |       |          |
| Fh-9h | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |      |             |    |          |       |                            |    |            |       |          |

### **D18F2x248\_dct[3:0]\_mp[1:0] DRAM Power Management 0**

Reset: 0000\_0A03h. See [2.9.3 \[DCT Configuration Registers\]](#).

| Bits    | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |      |             |     |           |     |         |         |                        |     |           |
|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|-----|-----------|-----|---------|---------|------------------------|-----|-----------|
| 31:30   | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |      |             |     |           |     |         |         |                        |     |           |
| 29:24   | <b>AggrPDDelay: aggressive power down delay.</b> Read-write. BIOS: 20h. Specifies a hysteresis count from the last DRAM activity for the DCT to close pages prior to precharge power down. Reserved if <a href="#">D18F2xA8_dct[3:0][AggrPDEn]</a> ==0. See <a href="#">PchgPDEnDelay</a> and <a href="#">D18F2x94_dct[3:0][PowerDownEn]</a> .<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00h</td><td>64 clocks</td></tr> <tr> <td>01h</td><td>1 clock</td></tr> <tr> <td>3Eh-02h</td><td>&lt;AggrPDDelay&gt; clocks</td></tr> <tr> <td>3Fh</td><td>63 clocks</td></tr> </table>                                                                                                                                                                                                                                                                                                  | Bits | Description | 00h | 64 clocks | 01h | 1 clock | 3Eh-02h | <AggrPDDelay> clocks   | 3Fh | 63 clocks |
| Bits    | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |      |             |     |           |     |         |         |                        |     |           |
| 00h     | 64 clocks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |      |             |     |           |     |         |         |                        |     |           |
| 01h     | 1 clock                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |      |             |     |           |     |         |         |                        |     |           |
| 3Eh-02h | <AggrPDDelay> clocks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |      |             |     |           |     |         |         |                        |     |           |
| 3Fh     | 63 clocks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |      |             |     |           |     |         |         |                        |     |           |
| 23:22   | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |      |             |     |           |     |         |         |                        |     |           |
| 21:16   | <b>PchgPDEnDelay: precharge power down entry delay.</b> Read-write.<br>BIOS: IF ( <a href="#">D18F2xA8_dct[3:0][AggrPDEn]</a> ) THEN (MaxRxCmdDelay + 5) ELSE 00h ENDIF. (See <a href="#">2.9.9.2.11</a> for information on MaxRxCmdDelay).<br>Specifies the power down entry delay. If <a href="#">D18F2xA8_dct[3:0][AggrPDEn]</a> ==0, this delay behaves as a hysteresis. This field must satisfy the minimum power down entry delay requirements. See also <a href="#">D18F2x94_dct[3:0][PowerDownEn]</a> .<br>PchgPDEnDelay == 0    PchgPDEnDelay >= MaxRxCmdDelay + 5. See <a href="#">2.9.9.2.11</a> for information on MaxRxCmdDelay.<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00h</td><td>64 clocks</td></tr> <tr> <td>01h</td><td>1 clock</td></tr> <tr> <td>3Eh-02h</td><td>&lt;PchgPDEnDelay&gt; clocks</td></tr> <tr> <td>3Fh</td><td>63 clocks</td></tr> </table> | Bits | Description | 00h | 64 clocks | 01h | 1 clock | 3Eh-02h | <PchgPDEnDelay> clocks | 3Fh | 63 clocks |
| Bits    | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |      |             |     |           |     |         |         |                        |     |           |
| 00h     | 64 clocks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |      |             |     |           |     |         |         |                        |     |           |
| 01h     | 1 clock                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |      |             |     |           |     |         |         |                        |     |           |
| 3Eh-02h | <PchgPDEnDelay> clocks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |      |             |     |           |     |         |         |                        |     |           |
| 3Fh     | 63 clocks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |      |             |     |           |     |         |         |                        |     |           |
| 15:13   | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |      |             |     |           |     |         |         |                        |     |           |

| 12:8    | <b>Txpdll: exit DLL and precharge powerdown to command delay.</b> Read-write. Specifies the minimum time that the DCT waits to issue a command after exiting precharge powerdown mode if the DLL was also disabled. Reserved if !Ddr3Mode.<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>09h-00h</td><td>Reserved</td></tr> <tr> <td>1Dh-0Ah</td><td>&lt;Txpdll&gt; clocks</td></tr> <tr> <td>1Fh-1Eh</td><td>Reserved</td></tr> </table> | Bits | Description | 09h-00h | Reserved | 1Dh-0Ah | <Txpdll> clocks | 1Fh-1Eh | Reserved |
|---------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|---------|----------|---------|-----------------|---------|----------|
| Bits    | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                 |      |             |         |          |         |                 |         |          |
| 09h-00h | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                    |      |             |         |          |         |                 |         |          |
| 1Dh-0Ah | <Txpdll> clocks                                                                                                                                                                                                                                                                                                                                                                                                                                             |      |             |         |          |         |                 |         |          |
| 1Fh-1Eh | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                    |      |             |         |          |         |                 |         |          |
| 7:4     | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                   |      |             |         |          |         |                 |         |          |
| 3:0     | <b>Txp: exit precharge PD to command delay.</b> Read-write. Specifies the minimum time that the DCT waits to issue a command after exiting precharge powerdown mode.<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>2h-0h</td><td>Reserved</td></tr> <tr> <td>8h-3h</td><td>&lt;Txp&gt; clocks</td></tr> <tr> <td>Fh-9h</td><td>Reserved</td></tr> </table>                                                                                | Bits | Description | 2h-0h   | Reserved | 8h-3h   | <Txp> clocks    | Fh-9h   | Reserved |
| Bits    | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                 |      |             |         |          |         |                 |         |          |
| 2h-0h   | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                    |      |             |         |          |         |                 |         |          |
| 8h-3h   | <Txp> clocks                                                                                                                                                                                                                                                                                                                                                                                                                                                |      |             |         |          |         |                 |         |          |
| Fh-9h   | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                    |      |             |         |          |         |                 |         |          |

### D18F2x24C\_dct[3:0] DDR3 DRAM Power Management 1

Reset: 0214\_0803h. See [2.9.3 \[DCT Configuration Registers\]](#).

| Bits    | Description                                                                                                                                                                                                                                                                                                                                                                                                         |      |             |         |          |         |                 |         |          |
|---------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|---------|----------|---------|-----------------|---------|----------|
| 31:30   | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                           |      |             |         |          |         |                 |         |          |
| 29:24   | <b>Tcksrx: clock stable to self refresh exit delay.</b> Read-write. Specifies the minimum time in memory clock cycles that the DCT waits to assert CKE after clock frequency is stable.<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>01h-00h</td><td>Reserved</td></tr> <tr> <td>0Eh-02h</td><td>&lt;Tcksrx&gt; clocks</td></tr> <tr> <td>3Fh-0Fh</td><td>Reserved</td></tr> </table>            | Bits | Description | 01h-00h | Reserved | 0Eh-02h | <Tcksrx> clocks | 3Fh-0Fh | Reserved |
| Bits    | Description                                                                                                                                                                                                                                                                                                                                                                                                         |      |             |         |          |         |                 |         |          |
| 01h-00h | Reserved                                                                                                                                                                                                                                                                                                                                                                                                            |      |             |         |          |         |                 |         |          |
| 0Eh-02h | <Tcksrx> clocks                                                                                                                                                                                                                                                                                                                                                                                                     |      |             |         |          |         |                 |         |          |
| 3Fh-0Fh | Reserved                                                                                                                                                                                                                                                                                                                                                                                                            |      |             |         |          |         |                 |         |          |
| 23:22   | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                           |      |             |         |          |         |                 |         |          |
| 21:16   | <b>Tcksre: self refresh to command delay.</b> Read-write. Specifies the minimum time in memory clock cycles that the DCT waits to remove external clocks after entering self refresh or powerdown.<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>04h-00h</td><td>Reserved</td></tr> <tr> <td>27h-05h</td><td>&lt;Tcksre&gt; clocks</td></tr> <tr> <td>3Fh-28h</td><td>Reserved</td></tr> </table> | Bits | Description | 04h-00h | Reserved | 27h-05h | <Tcksre> clocks | 3Fh-28h | Reserved |
| Bits    | Description                                                                                                                                                                                                                                                                                                                                                                                                         |      |             |         |          |         |                 |         |          |
| 04h-00h | Reserved                                                                                                                                                                                                                                                                                                                                                                                                            |      |             |         |          |         |                 |         |          |
| 27h-05h | <Tcksre> clocks                                                                                                                                                                                                                                                                                                                                                                                                     |      |             |         |          |         |                 |         |          |
| 3Fh-28h | Reserved                                                                                                                                                                                                                                                                                                                                                                                                            |      |             |         |          |         |                 |         |          |
| 15:14   | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                           |      |             |         |          |         |                 |         |          |
| 13:8    | <b>Tckesr: self refresh to command delay.</b> Read-write. Specifies the minimum time in memory clock cycles that the DCT waits to issue a command after entering self refresh.<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>01h-00h</td><td>Reserved</td></tr> <tr> <td>2Bh-02h</td><td>&lt;Tckesr&gt; clocks</td></tr> <tr> <td>3Fh-2Ch</td><td>Reserved</td></tr> </table>                     | Bits | Description | 01h-00h | Reserved | 2Bh-02h | <Tckesr> clocks | 3Fh-2Ch | Reserved |
| Bits    | Description                                                                                                                                                                                                                                                                                                                                                                                                         |      |             |         |          |         |                 |         |          |
| 01h-00h | Reserved                                                                                                                                                                                                                                                                                                                                                                                                            |      |             |         |          |         |                 |         |          |
| 2Bh-02h | <Tckesr> clocks                                                                                                                                                                                                                                                                                                                                                                                                     |      |             |         |          |         |                 |         |          |
| 3Fh-2Ch | Reserved                                                                                                                                                                                                                                                                                                                                                                                                            |      |             |         |          |         |                 |         |          |

| 7:4   | Reserved.                                                                                                                                                                                                                                                                                                                                        |      |             |    |          |       |              |       |          |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|----|----------|-------|--------------|-------|----------|
| 3:0   | <b>Tpd: minimum power down entry to exit.</b> Read-write. Specifies minimum time in memory clock cycles for powerdown entry to exit timing.<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>0h</td><td>Reserved</td></tr> <tr> <td>Ah-1h</td><td>&lt;Tpd&gt; clocks</td></tr> <tr> <td>Fh-Bh</td><td>Reserved</td></tr> </table> | Bits | Description | 0h | Reserved | Ah-1h | <Tpd> clocks | Fh-Bh | Reserved |
| Bits  | Description                                                                                                                                                                                                                                                                                                                                      |      |             |    |          |       |              |       |          |
| 0h    | Reserved                                                                                                                                                                                                                                                                                                                                         |      |             |    |          |       |              |       |          |
| Ah-1h | <Tpd> clocks                                                                                                                                                                                                                                                                                                                                     |      |             |    |          |       |              |       |          |
| Fh-Bh | Reserved                                                                                                                                                                                                                                                                                                                                         |      |             |    |          |       |              |       |          |

### D18F2x250\_dct[3:0] DRAM Loopback and Training Control

Reset: 0000\_0000h. See 2.9.3 [DCT Configuration Registers]. See 2.9.10 [Continuous Pattern Generation].

| Bits      | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                |      |             |      |                                    |      |                                                             |         |                            |           |          |
|-----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|------|------------------------------------|------|-------------------------------------------------------------|---------|----------------------------|-----------|----------|
| 31:21     | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                  |      |             |      |                                    |      |                                                             |         |                            |           |          |
| 20:17     | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                  |      |             |      |                                    |      |                                                             |         |                            |           |          |
| 16        | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                  |      |             |      |                                    |      |                                                             |         |                            |           |          |
| 15        | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                  |      |             |      |                                    |      |                                                             |         |                            |           |          |
| 14        | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                  |      |             |      |                                    |      |                                                             |         |                            |           |          |
| 13        | <b>LfsrRollOver: LFSR roll over.</b> IF (D18F2x118[LockDramCfg]) THEN Read-only. ELSE Read-write. ENDIF. Specifies the behavior of DataPrbsSeed and the data comparison logic if the generated address wraps around to equal D18F2x25[8,4]_dct[3:0][TgtAddress]. 0=The PRBS will not be re-seeded. 1=The PRBS will be re-seeded.                                                                                                                           |      |             |      |                                    |      |                                                             |         |                            |           |          |
| 12        | <b>CmdSendInProg: command in progress.</b> Read-only; updated-by-hardware. 0=DCT is idle. 1=DCT is busy.                                                                                                                                                                                                                                                                                                                                                   |      |             |      |                                    |      |                                                             |         |                            |           |          |
| 11        | <b>SendCmd: send command.</b> IF (D18F2x118[LockDramCfg]) THEN Read-only. ELSE Read-write. ENDIF. 0=Stop command generation. 1=Begin command generation as specified in CmdTgt, CmdType, and D18F2x260_dct[3:0][CmdCount]. BIOS must set this field to a 0 after a command series is completed. Reserved if ~CmdTestEnable.                                                                                                                                |      |             |      |                                    |      |                                                             |         |                            |           |          |
| 10        | <b>TestStatus: test status.</b> Read-only. 0=Command generation is in progress. 1=Command generation has completed. Reserved if ~(SendCmd & (D18F2x260_dct[3:0][CmdCount] > 0   StopOnErr)).                                                                                                                                                                                                                                                               |      |             |      |                                    |      |                                                             |         |                            |           |          |
| 9:8       | <b>CmdTgt: command target.</b> IF (D18F2x118[LockDramCfg]) THEN Read-only. ELSE Read-write. ENDIF. Specifies the SendCmd command target address mode. See D18F2x25[8,4]_dct[3:0].<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>Issue commands to address Target A</td></tr> <tr> <td>01b</td><td>Issue alternating commands to address Target A and Target B</td></tr> <tr> <td>11b-10b</td><td>Reserved</td></tr> </table> | Bits | Description | 00b  | Issue commands to address Target A | 01b  | Issue alternating commands to address Target A and Target B | 11b-10b | Reserved                   |           |          |
| Bits      | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                |      |             |      |                                    |      |                                                             |         |                            |           |          |
| 00b       | Issue commands to address Target A                                                                                                                                                                                                                                                                                                                                                                                                                         |      |             |      |                                    |      |                                                             |         |                            |           |          |
| 01b       | Issue alternating commands to address Target A and Target B                                                                                                                                                                                                                                                                                                                                                                                                |      |             |      |                                    |      |                                                             |         |                            |           |          |
| 11b-10b   | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                   |      |             |      |                                    |      |                                                             |         |                            |           |          |
| 7:5       | <b>CmdType: command type.</b> IF (D18F2x118[LockDramCfg]) THEN Read-only. ELSE Read-write. ENDIF. Specifies the SendCmd command type.<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>000b</td><td>Read</td></tr> <tr> <td>001b</td><td>Write</td></tr> <tr> <td>010b</td><td>Alternating write and read</td></tr> <tr> <td>111b-011b</td><td>Reserved</td></tr> </table>                                                                  | Bits | Description | 000b | Read                               | 001b | Write                                                       | 010b    | Alternating write and read | 111b-011b | Reserved |
| Bits      | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                |      |             |      |                                    |      |                                                             |         |                            |           |          |
| 000b      | Read                                                                                                                                                                                                                                                                                                                                                                                                                                                       |      |             |      |                                    |      |                                                             |         |                            |           |          |
| 001b      | Write                                                                                                                                                                                                                                                                                                                                                                                                                                                      |      |             |      |                                    |      |                                                             |         |                            |           |          |
| 010b      | Alternating write and read                                                                                                                                                                                                                                                                                                                                                                                                                                 |      |             |      |                                    |      |                                                             |         |                            |           |          |
| 111b-011b | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                   |      |             |      |                                    |      |                                                             |         |                            |           |          |

|     |                                                                                                                                                                                                                                                                                                                                         |
|-----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 4   | <b>StopOnError: stop on error.</b> IF (D18F2x118[LockDramCfg]) THEN Read-only. ELSE Read-write. ENDIF. Specifies the DCT behavior if a data comparison error occurs. 1=Stop command generation. 0=Continue command generation. If StopOnError=1, BIOS must program ResetAllErr=1 when programming SendCmd=1.                            |
| 3   | <b>ResetAllErr: reset all errors.</b> IF (D18F2x118[LockDramCfg]) THEN Read-only. ELSE Read; write-1-only; cleared-by-hardware. ENDIF. 1=Clear error status bits and error counters in D18F2x264_dct[3:0], D18F2x268_dct[3:0], and D18F2x26C_dct[3:0].                                                                                  |
| 2   | <b>CmdTestEnable: command test enable.</b> IF (D18F2x118[LockDramCfg]) THEN Read-only. ELSE Read-write. ENDIF. 0=Disable the command generation mode. 1=Enable the command generation mode. See SendCmd.<br>Software must disable data scrambling before using this logic to generate patterns. See D18F2xB60_dct[3:0][DataScrambleEn]. |
| 1:0 | Reserved.                                                                                                                                                                                                                                                                                                                               |

### D18F2x25[8,4]\_dct[3:0] DRAM Target [B, A] Base

Reset: 0000\_0000h. See 2.9.3 [DCT Configuration Registers]. See 2.9.10 [Continuous Pattern Generation].

Table 183: Register Mapping for D18F2x25[8,4]\_dct[3:0]

| Register           | Function |
|--------------------|----------|
| D18F2x254_dct[3:0] | Target A |
| D18F2x258_dct[3:0] | Target B |

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:27 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 26:24 | <b>TgtChipSelect: target chip select.</b> Read-write. Specifies the chip select.<br><div> <div>Bits</div> <div>Description</div> </div> 111b-000b CS<TgtChipSelect>                                                                                                                                                                                                                                                                                                                                                |
| 23:20 | <b>TgtBank: target bank [3:0].</b> Read-write. Specifies the bank address. If Ddr3Mode then TgtBank[3] is ignored.                                                                                                                                                                                                                                                                                                                                                                                                 |
| 19:16 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 15:10 | <b>TgtAddress[15:10]: target address [15:10].</b> Read-write. Specifies the upper column address bits [15:10]. Software must always program bit 10 and bit 12 equal to 0.                                                                                                                                                                                                                                                                                                                                          |
| 9:0   | <b>TgtAddress[9:0]: target address [9:0].</b> Read-write. Specifies the column address bits [9:0]. The address sequencing in a command series occurs as follows: TgtAddress[9:3] is incremented by one with wrap around. The increment occurs after each command if D18F2x250_dct[3:0][CmdType] = 00xb or if (D18F2x250_dct[3:0][CmdType] = 010b and D18F2x250_dct[3:0][CmdTgt] = 01b). The increment occurs after each command pair if (D18F2x250_dct[3:0][CmdType] = 010b and D18F2x250_dct[3:0][CmdTgt] = 00b). |

### D18F2x25C\_dct[3:0] DRAM Command 0

Reset: 0000\_0001h. See 2.9.3 [DCT Configuration Registers]. See 2.9.10 [Continuous Pattern Generation].

| Bits      | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |      |             |      |                   |           |                             |         |                                                                              |     |                                                                   |
|-----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|------|-------------------|-----------|-----------------------------|---------|------------------------------------------------------------------------------|-----|-------------------------------------------------------------------|
| 31:22     | <b>BubbleCnt2: bubble count 2.</b> See: BubbleCnt. Specifies the number of NOP commands inserted after the last clock of virtual CAS of each read-burst operation in alternating write and read mode. Defined only if (D18F2x250_dct[3:0][CmdType] == 010b); otherwise reserved.                                                                                                                                                                                                                               |      |             |      |                   |           |                             |         |                                                                              |     |                                                                   |
| 21:12     | <b>BubbleCnt: bubble count.</b> Read-write. Specifies the number of NOP commands inserted after the last clock of virtual CAS of the last command of the command stream specified by CmdStreamLen. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>000h</td><td>0 command bubbles</td></tr> <tr> <td>3FEh-001h</td><td>&lt;BubbleCnt&gt; command bubbles</td></tr> <tr> <td>3FFh</td><td>3FFh command bubbles</td></tr> </table>                                                                  | Bits | Description | 000h | 0 command bubbles | 3FEh-001h | <BubbleCnt> command bubbles | 3FFh    | 3FFh command bubbles                                                         |     |                                                                   |
| Bits      | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |      |             |      |                   |           |                             |         |                                                                              |     |                                                                   |
| 000h      | 0 command bubbles                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |      |             |      |                   |           |                             |         |                                                                              |     |                                                                   |
| 3FEh-001h | <BubbleCnt> command bubbles                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |      |             |      |                   |           |                             |         |                                                                              |     |                                                                   |
| 3FFh      | 3FFh command bubbles                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |      |             |      |                   |           |                             |         |                                                                              |     |                                                                   |
| 11:9      | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |      |             |      |                   |           |                             |         |                                                                              |     |                                                                   |
| 8         | <b>CmdTimingEn: command timing enable.</b> Read-write. 1=Forces DCT to schedule commands initiated by D18F2x250_dct[3:0][SendCmd] to adhere to the same DRAM timing parameters as normal traffic. 0=Commands initiated by D18F2x250_dct[3:0][SendCmd] ignore DRAM timing parameters.                                                                                                                                                                                                                           |      |             |      |                   |           |                             |         |                                                                              |     |                                                                   |
| 7:0       | <b>CmdStreamLen: command stream length.</b> Read-write. Specifies the number of commands generated before BubbleCnt bubbles are inserted. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00h</td><td>Reserved</td></tr> <tr> <td>01h</td><td>1 command</td></tr> <tr> <td>FEh-02h</td><td>&lt;CmdStreamLen&gt; commands; defined only if ~(D18F2x250_dct[3:0][CmdType]=010b)</td></tr> <tr> <td>FFh</td><td>255 commands; defined only if ~(D18F2x250_dct[3:0][CmdType]=010b)</td></tr> </table> | Bits | Description | 00h  | Reserved          | 01h       | 1 command                   | FEh-02h | <CmdStreamLen> commands; defined only if ~(D18F2x250_dct[3:0][CmdType]=010b) | FFh | 255 commands; defined only if ~(D18F2x250_dct[3:0][CmdType]=010b) |
| Bits      | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |      |             |      |                   |           |                             |         |                                                                              |     |                                                                   |
| 00h       | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |      |             |      |                   |           |                             |         |                                                                              |     |                                                                   |
| 01h       | 1 command                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |      |             |      |                   |           |                             |         |                                                                              |     |                                                                   |
| FEh-02h   | <CmdStreamLen> commands; defined only if ~(D18F2x250_dct[3:0][CmdType]=010b)                                                                                                                                                                                                                                                                                                                                                                                                                                   |      |             |      |                   |           |                             |         |                                                                              |     |                                                                   |
| FFh       | 255 commands; defined only if ~(D18F2x250_dct[3:0][CmdType]=010b)                                                                                                                                                                                                                                                                                                                                                                                                                                              |      |             |      |                   |           |                             |         |                                                                              |     |                                                                   |

### D18F2x260\_dct[3:0] DRAM Command 1

Reset: 0000\_0000h. See 2.9.3 [DCT Configuration Registers]. See 2.9.10 [Continuous Pattern Generation].

| Bits        | Description                                                                                                                                                                                                                                                                                                                                                 |      |             |    |                    |             |                     |
|-------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|----|--------------------|-------------|---------------------|
| 31:21       | Reserved.                                                                                                                                                                                                                                                                                                                                                   |      |             |    |                    |             |                     |
| 20:0        | <b>CmdCount: command count.</b> Read-write. Specifies the maximum number of commands to generate when D18F2x250_dct[3:0][SendCmd]=1. See also D18F2x250_dct[3:0][StopOnErr]. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>0h</td><td>Infinite commands.</td></tr> <tr> <td>1F_FFFFh-1h</td><td>&lt;CmdCount&gt; commands</td></tr> </table> | Bits | Description | 0h | Infinite commands. | 1F_FFFFh-1h | <CmdCount> commands |
| Bits        | Description                                                                                                                                                                                                                                                                                                                                                 |      |             |    |                    |             |                     |
| 0h          | Infinite commands.                                                                                                                                                                                                                                                                                                                                          |      |             |    |                    |             |                     |
| 1F_FFFFh-1h | <CmdCount> commands                                                                                                                                                                                                                                                                                                                                         |      |             |    |                    |             |                     |

### D18F2x264\_dct[3:0] DRAM Status 0

Reset: 0000\_0000h. See 2.9.3 [DCT Configuration Registers]. See 2.9.10 [Continuous Pattern Generation].

| Bits         | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |      |             |         |                  |              |                 |           |                  |           |                          |
|--------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|---------|------------------|--------------|-----------------|-----------|------------------|-----------|--------------------------|
| 31:25        | <b>ErrDqNum: error DQ number.</b> Read-only. Indicates the DQ bit of the first error occurrence when <a href="#">D18F2x264_dct[3:0][ErrCnt]</a> > 0. Cleared by <a href="#">D18F2x250_dct[3:0][ResetAllErr]</a> . <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>3Fh-00h</td><td>Data[&lt;ErrDqNum&gt;]</td></tr> <tr> <td>47h-40h</td><td>ECC[7:0]</td></tr> <tr> <td>7Fh-48h</td><td>Reserved</td></tr> </table>                                                                                                                                                                                                                                                                                                                                        | Bits | Description | 3Fh-00h | Data[<ErrDqNum>] | 47h-40h      | ECC[7:0]        | 7Fh-48h   | Reserved         |           |                          |
| Bits         | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |      |             |         |                  |              |                 |           |                  |           |                          |
| 3Fh-00h      | Data[<ErrDqNum>]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |      |             |         |                  |              |                 |           |                  |           |                          |
| 47h-40h      | ECC[7:0]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |      |             |         |                  |              |                 |           |                  |           |                          |
| 7Fh-48h      | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |      |             |         |                  |              |                 |           |                  |           |                          |
| 24:0         | <b>ErrCnt: error count.</b> Read; set-by-hardware; write-1-to-clear. Specifies a saturating counter indicating the number of DQ bit errors detected. Counts a maximum of 1 error per bit-lane per each bit-time. Status is accumulated until cleared by <a href="#">D18F2x250_dct[3:0][ResetAllErr]</a> . Errors can be masked on per-bit basis by programming <a href="#">D18F2x274_dct[3:0]</a> , <a href="#">D18F2x278_dct[3:0]</a> , and <a href="#">D18F2x27C_dct[3:0]</a> . <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>0h</td><td>0 errors</td></tr> <tr> <td>1FF_FFFDh-1h</td><td>&lt;ErrCnt&gt; errors</td></tr> <tr> <td>1FF_FFFEh</td><td>1FF_FFFEh errors</td></tr> <tr> <td>1FF_FFFFh</td><td>1FF_FFFFh or more errors</td></tr> </table> | Bits | Description | 0h      | 0 errors         | 1FF_FFFDh-1h | <ErrCnt> errors | 1FF_FFFEh | 1FF_FFFEh errors | 1FF_FFFFh | 1FF_FFFFh or more errors |
| Bits         | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |      |             |         |                  |              |                 |           |                  |           |                          |
| 0h           | 0 errors                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |      |             |         |                  |              |                 |           |                  |           |                          |
| 1FF_FFFDh-1h | <ErrCnt> errors                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |      |             |         |                  |              |                 |           |                  |           |                          |
| 1FF_FFFEh    | 1FF_FFFEh errors                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |      |             |         |                  |              |                 |           |                  |           |                          |
| 1FF_FFFFh    | 1FF_FFFFh or more errors                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |      |             |         |                  |              |                 |           |                  |           |                          |

#### **D18F2x268\_dct[3:0] DRAM Status 1**

Reset: 0000\_0000h. See 2.9.3 [DCT Configuration Registers]. See 2.9.10 [Continuous Pattern Generation].

| Bits    | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |     |             |        |                                             |      |          |      |          |         |          |
|---------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-------------|--------|---------------------------------------------|------|----------|------|----------|---------|----------|
| 31:20   | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |     |             |        |                                             |      |          |      |          |         |          |
| 19:0    | <b>NibbleErrSts: nibble error status.</b> Read-only. Indicates error detection status on a per nibble basis when <a href="#">D18F2x264_dct[3:0][ErrCnt]</a> > 0. Status is accumulated until cleared by <a href="#">D18F2x250_dct[3:0][ResetAllErr]</a> . <table> <tr> <th>Bit</th><th>Description</th></tr> <tr> <td>[15:0]</td><td>Data[&lt;(NibbleErrSts*4)+3&gt;:&lt;NibbleErrSts*4&gt;]</td></tr> <tr> <td>[16]</td><td>ECC[3:0]</td></tr> <tr> <td>[17]</td><td>ECC[7:4]</td></tr> <tr> <td>[19:18]</td><td>Reserved</td></tr> </table> | Bit | Description | [15:0] | Data[<(NibbleErrSts*4)+3>:<NibbleErrSts*4>] | [16] | ECC[3:0] | [17] | ECC[7:4] | [19:18] | Reserved |
| Bit     | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |     |             |        |                                             |      |          |      |          |         |          |
| [15:0]  | Data[<(NibbleErrSts*4)+3>:<NibbleErrSts*4>]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |     |             |        |                                             |      |          |      |          |         |          |
| [16]    | ECC[3:0]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |     |             |        |                                             |      |          |      |          |         |          |
| [17]    | ECC[7:4]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |     |             |        |                                             |      |          |      |          |         |          |
| [19:18] | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |     |             |        |                                             |      |          |      |          |         |          |

#### **D18F2x26C\_dct[3:0] DRAM Status 2**

Reset: 0000\_0000h. See 2.9.3 [DCT Configuration Registers]. See 2.9.10 [Continuous Pattern Generation].

| Bits | Description |
|------|-------------|
|------|-------------|

| 31:18  | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |     |             |        |                                                    |      |          |      |          |
|--------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-------------|--------|----------------------------------------------------|------|----------|------|----------|
| 17:0   | <p><b>NibbleErr180Sts: nibble error 180 status.</b> Read-only. Indicates error detection status on a per nibble basis when <a href="#">D18F2x264_dct[3:0][ErrCnt]</a> &gt; 0, comparing read data against data shifted 1-bit time earlier. Status is accumulated until cleared by <a href="#">D18F2x250_dct[3:0][ResetAllErr]</a>.</p> <table> <tr> <th>Bit</th><th>Description</th></tr> <tr> <td>[15:0]</td><td>Data[&lt;(NibbleErr180Sts)*4&gt;+3&gt;:&lt;NibbleErr180Sts*4&gt;]</td></tr> <tr> <td>[16]</td><td>ECC[3:0]</td></tr> <tr> <td>[17]</td><td>ECC[7:4]</td></tr> </table> | Bit | Description | [15:0] | Data[<(NibbleErr180Sts)*4>+3>:<NibbleErr180Sts*4>] | [16] | ECC[3:0] | [17] | ECC[7:4] |
| Bit    | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |     |             |        |                                                    |      |          |      |          |
| [15:0] | Data[<(NibbleErr180Sts)*4>+3>:<NibbleErr180Sts*4>]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |     |             |        |                                                    |      |          |      |          |
| [16]   | ECC[3:0]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |     |             |        |                                                    |      |          |      |          |
| [17]   | ECC[7:4]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |     |             |        |                                                    |      |          |      |          |

### **D18F2x270\_dct[3:0] DRAM PRBS**

See [2.9.3 \[DCT Configuration Registers\]](#). See [2.9.10 \[Continuous Pattern Generation\]](#).

| Bits  | Description                                                                                                                                                                                                 |
|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31    | Reserved.                                                                                                                                                                                                   |
| 30:24 | Reserved.                                                                                                                                                                                                   |
| 23:19 | Reserved.                                                                                                                                                                                                   |
| 18:0  | <b>DataPrbsSeed: data PRBS seed.</b> Read-write. Reset: 7FFFFh. Specifies the seed value used for creating pseudo random traffic on the data bus. This register must be written with a non-zero seed value. |

### **D18F2x274\_dct[3:0] DRAM DQ Mask Low**

See [D18F1x10C\[DctCfgSel\]](#). See [2.9.3 \[DCT Configuration Registers\]](#). See [2.9.10 \[Continuous Pattern Generation\]](#).

| Bits   | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |     |             |     |         |        |                |      |          |
|--------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-------------|-----|---------|--------|----------------|------|----------|
| 31:0   | <p><b>DQMask[31:0]: DQ mask.</b> Read-write. DQMask[63:0] = {<a href="#">D18F2x278_dct[3:0][DQMask[63:32]]</a>, DQMask[31:0]}. Reset: 0000_0000_0000_0000h. 1=The corresponding DQ bit will not be compared. 0=The corresponding DQ bit will be compared. See <a href="#">D18F2x264_dct[3:0][ErrCnt]</a>.</p> <table> <tr> <th>Bit</th><th>Description</th></tr> <tr> <td>[0]</td><td>Data[0]</td></tr> <tr> <td>[62:1]</td><td>Data[&lt;DQMask&gt;]</td></tr> <tr> <td>[63]</td><td>Data[63]</td></tr> </table> | Bit | Description | [0] | Data[0] | [62:1] | Data[<DQMask>] | [63] | Data[63] |
| Bit    | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |     |             |     |         |        |                |      |          |
| [0]    | Data[0]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |     |             |     |         |        |                |      |          |
| [62:1] | Data[<DQMask>]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |     |             |     |         |        |                |      |          |
| [63]   | Data[63]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |     |             |     |         |        |                |      |          |

### **D18F2x278\_dct[3:0] DRAM DQ Mask High**

| Bits | Description                                                                            |
|------|----------------------------------------------------------------------------------------|
| 31:0 | <b>DQMask[63:32]: DQ mask.</b> See: <a href="#">D18F2x274_dct[3:0][DQMask[31:0]]</a> . |

### **D18F2x27C\_dct[3:0] DRAM ECC and EDC Mask**

Reset: 0000\_0000h. See [2.9.3 \[DCT Configuration Registers\]](#). See [2.9.10 \[Continuous Pattern Generation\]](#).

| Bits  | Description |
|-------|-------------|
| 31:20 | Reserved.   |

|                                   |                                                                                                                                                                                              |
|-----------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 19:16                             | Reserved.                                                                                                                                                                                    |
| 15:8                              | Reserved.                                                                                                                                                                                    |
| 7:0                               | <b>EccMask: ECC mask.</b> Read-write. 1=The corresponding ECC DQ bit will not be compared. 0=The corresponding ECC DQ bit will be compared. See <a href="#">D18F2x264_dct[3:0][ErrCnt]</a> . |
| <u>Bit</u><br>[0]<br>[6:1]<br>[7] | <u>Description</u><br>ECC[0]<br>ECC[<EccMask>]<br>ECC[7].                                                                                                                                    |

### D18F2x28C\_dct[3:0] DRAM Command 2

Reset: 0000\_0000h. See [2.9.3 \[DCT Configuration Registers\]](#). See [2.9.10 \[Continuous Pattern Generation\]](#). This register may only be used when [D18F2x250\\_dct\[3:0\]\[CmdTestEnable\]](#)=1.

| Bits                          | Description                                                                                                                                                                                                                                                                                                                                                                                                                    |
|-------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31                            | <b>SendActCmd: send activate command.</b> Read; write-1-only; cleared-by-hardware. 1=The DCT sends an activate command as specified by ChipSelect, Bank, and Address. This bit is cleared by hardware after the command completes.                                                                                                                                                                                             |
| 30                            | <b>SendPchgCmd: send precharge all command.</b> Read; write-1-only; cleared-by-hardware. The DCT sends a precharge command based on CmdAddress[10]. This bit is cleared by hardware after the command completes. 0=Command has completed. 1=If (CmdAddress[10]=1) then send a precharge all command as specified by CmdChipSelect; If (CmdAddress[10]=0) then send a precharge command as specified by CmdChipSelect, CmdBank. |
| 29:22                         | <b>CmdChipSelect: command chip select.</b> Read-write. Specifies the chip select.                                                                                                                                                                                                                                                                                                                                              |
| <u>Bit</u><br>[7:0]           | <u>Description</u><br>CS<CmdChipSelect>                                                                                                                                                                                                                                                                                                                                                                                        |
| 21:18                         | <b>CmdBank: command bank [3:0].</b> Read-write. Specifies the bank address.                                                                                                                                                                                                                                                                                                                                                    |
| <u>Bits</u><br>7h-0h<br>Fh-8h | <u>Description</u><br>Bank<CmdBank><br>Reserved.                                                                                                                                                                                                                                                                                                                                                                               |
| 17:0                          | <b>CmdAddress: command address [17:0].</b> Read-write. Specifies the row address.                                                                                                                                                                                                                                                                                                                                              |

### D18F2x290\_dct[3:0] DRAM Status 3

Reset: 0000\_0000h. See [2.9.3 \[DCT Configuration Registers\]](#). See [2.9.10 \[Continuous Pattern Generation\]](#).

| Bits  | Description |
|-------|-------------|
| 31:27 | Reserved.   |



| 26:24       | <b>ErrBeatNum: error beat number.</b> Read-only. Indicates the data beat of the first error occurrence in the command reported by ErrCmdNum when <a href="#">D18F2x264_dct[3:0][ErrCnt]</a> > 0 and <a href="#">D18F2x260_dct[3:0][CmdCount]</a> > 0. Cleared by <a href="#">D18F2x250_dct[3:0][ResetAllErr]</a> .<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>7h-0h</td><td>&lt;ErrBeatNum&gt; beat</td></tr> </table> | Bits | Description | 7h-0h       | <ErrBeatNum> beat   |
|-------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|-------------|---------------------|
| Bits        | Description                                                                                                                                                                                                                                                                                                                                                                                                                                 |      |             |             |                     |
| 7h-0h       | <ErrBeatNum> beat                                                                                                                                                                                                                                                                                                                                                                                                                           |      |             |             |                     |
| 23:21       | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                   |      |             |             |                     |
| 20:0        | <b>ErrCmdNum: error command number.</b> Read-only. Indicates the command number of the first error occurrence when <a href="#">D18F2x264_dct[3:0][ErrCnt]</a> > 0 and <a href="#">D18F2x260_dct[3:0][CmdCount]</a> > 0. Cleared by <a href="#">D18F2x250_dct[3:0][ResetAllErr]</a> .<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>1F_FFFFh-0h</td><td>&lt;ErrCmdNum&gt; command</td></tr> </table>                       | Bits | Description | 1F_FFFFh-0h | <ErrCmdNum> command |
| Bits        | Description                                                                                                                                                                                                                                                                                                                                                                                                                                 |      |             |             |                     |
| 1F_FFFFh-0h | <ErrCmdNum> command                                                                                                                                                                                                                                                                                                                                                                                                                         |      |             |             |                     |

#### D18F2x294\_dct[3:0] DRAM Status 4

See [2.9.3 \[DCT Configuration Registers\]](#). See [2.9.10 \[Continuous Pattern Generation\]](#).

| Bits   | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |     |             |     |         |        |               |      |          |
|--------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-------------|-----|---------|--------|---------------|------|----------|
| 31:0   | <b>DQErr[31:0]: DQ error.</b> Read-only. DQErr[63:0] = { <a href="#">D18F2x298_dct[3:0][DQErr[63:32]]</a> , DQErr[31:0]}. Reset: 0000_0000_0000_0000h. Indicates error detection status on a per bit basis when <a href="#">D18F2x264_dct[3:0][ErrCnt]</a> > 0. Status is accumulated until cleared by <a href="#">D18F2x250_dct[3:0][ResetAllErr]</a> .<br><table> <tr> <th>Bit</th><th>Description</th></tr> <tr> <td>[0]</td><td>Data[0]</td></tr> <tr> <td>[62:1]</td><td>Data[&lt;DQErr&gt;]</td></tr> <tr> <td>[63]</td><td>Data[63]</td></tr> </table> | Bit | Description | [0] | Data[0] | [62:1] | Data[<DQErr>] | [63] | Data[63] |
| Bit    | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |     |             |     |         |        |               |      |          |
| [0]    | Data[0]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |     |             |     |         |        |               |      |          |
| [62:1] | Data[<DQErr>]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |     |             |     |         |        |               |      |          |
| [63]   | Data[63]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |     |             |     |         |        |               |      |          |

#### D18F2x298\_dct[3:0] DRAM Status 5

| Bits | Description                                                                           |
|------|---------------------------------------------------------------------------------------|
| 31:0 | <b>DQErr[63:32]: DQ error.</b> See: <a href="#">D18F2x294_dct[3:0][DQErr[31:0]]</a> . |

#### D18F2x29C\_dct[3:0] DRAM Status 6

Reset: 0000\_0000h. See [2.9.3 \[DCT Configuration Registers\]](#). See [2.9.10 \[Continuous Pattern Generation\]](#).

| Bits  | Description |
|-------|-------------|
| 31:20 | Reserved.   |
| 19:16 | Reserved.   |

| 15:8  | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                         |     |             |     |        |       |               |     |        |
|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-------------|-----|--------|-------|---------------|-----|--------|
| 7:0   | <p><b>EccErr: ECC error.</b> Read-only. Indicates ECC error detection status on a per bit basis when <a href="#">D18F2x264_dct[3:0][ErrCnt]</a> &gt; 0. Status is accumulated until cleared by <a href="#">D18F2x250_dct[3:0][Reset-AllErr]</a>.</p> <table> <tr> <th>Bit</th><th>Description</th></tr> <tr> <td>[0]</td><td>ECC[0]</td></tr> <tr> <td>[6:1]</td><td>ECC[&lt;EccErr&gt;]</td></tr> <tr> <td>[7]</td><td>ECC[7]</td></tr> </table> | Bit | Description | [0] | ECC[0] | [6:1] | ECC[<EccErr>] | [7] | ECC[7] |
| Bit   | Description                                                                                                                                                                                                                                                                                                                                                                                                                                       |     |             |     |        |       |               |     |        |
| [0]   | ECC[0]                                                                                                                                                                                                                                                                                                                                                                                                                                            |     |             |     |        |       |               |     |        |
| [6:1] | ECC[<EccErr>]                                                                                                                                                                                                                                                                                                                                                                                                                                     |     |             |     |        |       |               |     |        |
| [7]   | ECC[7]                                                                                                                                                                                                                                                                                                                                                                                                                                            |     |             |     |        |       |               |     |        |

### **D18F2x2E0\_dct[3:0] Memory P-state Control and Status**

See 2.9.3 [DCT Configuration Registers].

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |     |                       |     |                                                        |     |                                                        |     |                                                        |
|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----------------------|-----|--------------------------------------------------------|-----|--------------------------------------------------------|-----|--------------------------------------------------------|
| 31    | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |     |                       |     |                                                        |     |                                                        |     |                                                        |
| 30    | <b>FastMstateDis: fast M-state change disable.</b> Read-write. Reset: 0. 1=The DCT changes MEMCLK frequency only after the NCLK frequency has changed. 0=The DCT changes MEMCLK frequency while the northbridge changes NCLK.                                                                                                                                                                                                                                                                                                 |     |                       |     |                                                        |     |                                                        |     |                                                        |
| 29    | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |     |                       |     |                                                        |     |                                                        |     |                                                        |
| 28:24 | <b>M1MemClkFreq: M1 memory clock frequency.</b> Read-write. Reset: 00h. Specifies the frequency of the DRAM interface (MEMCLK) for memory P-state 1. See <a href="#">Table 141 [Valid Values for Memory Clock Frequency Value Definition]</a> . The hardware enforces <a href="#">D18F5x84[DdrMaxRateEnf]</a> when writes to this field occur. See <a href="#">D18F5x84[DdrMaxRate]</a> and <a href="#">D18F5x84[DdrMaxRateEnf]</a> . BIOS must also program <a href="#">D18F2x9C_x0002_0001_dct[3:0][PllMultDiv]</a> for M1. |     |                       |     |                                                        |     |                                                        |     |                                                        |
| 23    | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |     |                       |     |                                                        |     |                                                        |     |                                                        |
| 22:20 | <p><b>MxMrsEn: Mx Mrs enable.</b> Read-write. Reset: 0h. 1=The DCT writes to the DRAM MR after a memory P-state change. 0=The DCT does not write to the DRAM MR.</p> <table> <tr> <th>Bit</th><th>Description, MR value</th></tr> <tr> <td>[0]</td><td>MR0, <a href="#">D18F2x2E8_dct[3:0]_mp[1:0][MxMr0]</a></td></tr> <tr> <td>[1]</td><td>MR1, <a href="#">D18F2x2E8_dct[3:0]_mp[1:0][MxMr1]</a></td></tr> <tr> <td>[2]</td><td>MR2, <a href="#">D18F2x2EC_dct[3:0]_mp[1:0][MxMr2]</a></td></tr> </table>                  | Bit | Description, MR value | [0] | MR0, <a href="#">D18F2x2E8_dct[3:0]_mp[1:0][MxMr0]</a> | [1] | MR1, <a href="#">D18F2x2E8_dct[3:0]_mp[1:0][MxMr1]</a> | [2] | MR2, <a href="#">D18F2x2EC_dct[3:0]_mp[1:0][MxMr2]</a> |
| Bit   | Description, MR value                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |     |                       |     |                                                        |     |                                                        |     |                                                        |
| [0]   | MR0, <a href="#">D18F2x2E8_dct[3:0]_mp[1:0][MxMr0]</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |     |                       |     |                                                        |     |                                                        |     |                                                        |
| [1]   | MR1, <a href="#">D18F2x2E8_dct[3:0]_mp[1:0][MxMr1]</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |     |                       |     |                                                        |     |                                                        |     |                                                        |
| [2]   | MR2, <a href="#">D18F2x2EC_dct[3:0]_mp[1:0][MxMr2]</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |     |                       |     |                                                        |     |                                                        |     |                                                        |
| 19:1  | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |     |                       |     |                                                        |     |                                                        |     |                                                        |
| 0     | <b>CurMemPstate: current memory P-state.</b> Reset: 0h. Read-only; updated-by-hardware. Specifies the current memory P-state. 0=M0. 1=M1.                                                                                                                                                                                                                                                                                                                                                                                     |     |                       |     |                                                        |     |                                                        |     |                                                        |

### **D18F2x2E8\_dct[3:0]\_mp[1:0] MRS Buffer**

See 2.9.3 [DCT Configuration Registers].

| Bits | Description |
|------|-------------|
|------|-------------|

|       |                                                                                                                                                                                                                                                                                        |
|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:16 | <b>MxMr1: Mx MR1.</b> Read-write. Reset: 0000h. Specifies the value written to DRAM MR1 after a memory P-state change. If the M1 value is the same as the M0 value, then BIOS should optimize P-state switching latency by programming <a href="#">D18F2x2E0_dct[3:0][MxMrsEn]</a> =0. |
| 15:0  | <b>MxMr0: Mx MR0.</b> Read-write. Reset: 0000h. Specifies the value written to DRAM MR0 after a memory P-state change. If the M1 value is the same as the M0 value, then BIOS should optimize P-state switching latency by programming <a href="#">D18F2x2E0_dct[3:0][MxMrsEn]</a> =0. |

#### **D18F2x2EC\_dct[3:0]\_mp[1:0] MRS Buffer**

See [2.9.3 \[DCT Configuration Registers\]](#).

| Bits  | Description                                                                                                                                                                                                                                                                            |
|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:16 | Reserved.                                                                                                                                                                                                                                                                              |
| 15:0  | <b>MxMr2: Mx MR2.</b> Read-write. Reset: 0000h. Specifies the value written to DRAM MR2 after a memory P-state change. If the M1 value is the same as the M0 value, then BIOS should optimize P-state switching latency by programming <a href="#">D18F2x2E0_dct[3:0][MxMrsEn]</a> =0. |

#### **D18F2x2F0\_dct[3:0]\_mp[1:0] DRAM Controller Misc 3**

See [2.9.3 \[DCT Configuration Registers\]](#).

| Bits | Description                                                                                                                                                                                                                                                                                      |
|------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:1 | Reserved.                                                                                                                                                                                                                                                                                        |
| 0    | <b>EffArbDis: Efficient arbitration disable.</b> Read-write. Reset: 0. BIOS: 0. 0=The DCT optimizes the arbitration phases to improve performance under certain traffic conditions whenever the NCLK to MEMCLK ratio is less than 2:1. 1=The DCT arbitrates normally, at all NCLK:MEMCLK ratios. |

#### **D18F2x400\_dct[3:0] GMC to DCT Control 0**

Reset: 0000\_0000h. See [2.9.3 \[DCT Configuration Registers\]](#).

The GMC to DCT interface controls how DRAM bus resources are allocated and arbitrated between the MCT and the GMC. A token is the unit of available resource and is equivalent to a DCQ entry. A minimum count ensures a number of available DCQ entries. A token limit for MCT or GMC ensures resources are not all allocated to the GMC, or MCT respectively. Limits are configured bimodal: for normal GMC traffic and for when urgent (nominally display refresh) GMC traffic is occurring.

[D18F2x400\\_dct\[3:0\]\[MctTokenLimit\]](#) == [D18F2x404\\_dct\[3:0\]\[UrMctTokenLimit\]](#).

| Bits  | Description                                                                                                                                                                                                               |
|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:16 | Reserved.                                                                                                                                                                                                                 |
| 15:12 | Reserved.                                                                                                                                                                                                                 |
| 11:8  | <b>GmcTokenLimit: GMC token limit.</b> Read-write.BIOS: 4h. Limit of outstanding GMC tokens.<br><div> <div>Bits</div> <div>Description</div> </div> <div> <div>Fh-0h</div> <div>&lt;GmcTokenLimit&gt; tokens</div> </div> |

|     |                                                                                                                                                                                                                            |
|-----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 7:4 | Reserved.                                                                                                                                                                                                                  |
| 3:0 | <b>MctTokenLimit: MCT token limit.</b> Read-write. BIOS: 4h. Limit of outstanding MCT tokens.<br><div> <div>Bits</div> <div>Fh-0h</div> </div> <div> <div>Description</div> <div>&lt;MctTokenLimit&gt; tokens</div> </div> |

#### D18F2x404\_dct[3:0] GMC to DCT Control 1

Reset: 0000\_0000h. See [2.9.3 \[DCT Configuration Registers\]](#).

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31    | <b>UrgentTknDis: Urgent token disable.</b> Read-write. BIOS: 0. 0=When urgent GMC traffic is requested , override the programmed values in <a href="#">D18F2x400_dct[3:0]</a> and force the token scheme to heavily weight towards graphics by using the programmable token limits in <a href="#">D18F2x404_dct[3:0]</a> . 1=Token scheme remains at the previously programmed non-urgent token limits in <a href="#">D18F2x400_dct[3:0]</a> regardless of urgent GMC traffic. |
| 30:28 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| 27:24 | <b>UrGmcMinTokens: Display refresh GMC minimum tokens.</b> Read-write. BIOS: 4. Urgent mode minimum number of tokens assigned to the GMC.<br><div> <div>Bits</div> <div>Fh-0h</div> </div> <div> <div>Description</div> <div>&lt;UrGmcMinTokens&gt; tokens</div> </div>                                                                                                                                                                                                        |
| 23:21 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| 20:16 | <b>UrGmcTokenLimit: Display refresh GMC token limit.</b> Read-write. BIOS: 04h. Urgent mode limit of outstanding GMC tokens.<br><div> <div>Bits</div> <div>10h-0h</div> <div>1Fh-11h</div> </div> <div> <div>Description</div> <div>&lt;UrGmcTokenLimit&gt; tokens</div> <div>Reserved</div> </div>                                                                                                                                                                            |
| 15:12 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| 11:8  | <b>UrMctMinTokens: Display refresh MCT minimum tokens.</b> Read-write. BIOS: 4. Urgent mode minimum number of tokens assigned to the MCT.<br><div> <div>Bits</div> <div>Fh-0h</div> </div> <div> <div>Description</div> <div>&lt;UrMctMinTokens&gt; tokens</div> </div>                                                                                                                                                                                                        |
| 7:5   | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| 4:0   | <b>UrMctTokenLimit: Display refresh MCT token limit.</b> Read-write. BIOS: 04h. Urgent mode limit of outstanding MCT tokens.<br><div> <div>Bits</div> <div>10h-0h</div> <div>1Fh-11h</div> </div> <div> <div>Description</div> <div>&lt;UrMctTokenLimit&gt; tokens</div> <div>Reserved</div> </div>                                                                                                                                                                            |

#### D18F2x408\_dct[3:0] GMC to DCT Control 2

See [2.9.3 \[DCT Configuration Registers\]](#).

| Bits  | Description |
|-------|-------------|
| 31:29 | Reserved.   |

| 28:24   | <p><b>CpuElevPrioPeriod: Cpu elevate priority period.</b> Read-write. Reset: 0. BIOS: Ch. Specifies the hysteresis of how often a new MCT read can be elevated to high priority if no other MCT reads currently exist in the DCQ. If CpuElevPrioPeriod==0, MCT will continuously elevate the priority of a new lone MCT read to high. Reserved if CpuElevPrioDis==1. Since this field controls internal timing in the NCLK domain, external bus equivalence is approximate.</p> <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00h</td><td>hysteresis counter disabled</td></tr> <tr> <td>1Fh-01h</td><td>&lt;CpuElevPrioPeriod*32&gt; MEMCLKs</td></tr> </table> | Bits | Description | 00h | hysteresis counter disabled | 1Fh-01h | <CpuElevPrioPeriod*32> MEMCLKs |
|---------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|-----|-----------------------------|---------|--------------------------------|
| Bits    | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |      |             |     |                             |         |                                |
| 00h     | hysteresis counter disabled                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |      |             |     |                             |         |                                |
| 1Fh-01h | <CpuElevPrioPeriod*32> MEMCLKs                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |      |             |     |                             |         |                                |
| 23:3    | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |      |             |     |                             |         |                                |
| 2       | <p><b>NonP0UrgentTknDis: non-P0 urgent token disable.</b> Read-write. Reset: 0. BIOS: 0. 0=Switch from normal GMC traffic token scheme defined by <a href="#">D18F2x400_dct[3:0]</a> to urgent GMC traffic token scheme defined by <a href="#">D18F2x404_dct[3:0]</a> when all processors are not in software P0 state. 1=Use normal GMC traffic token scheme when all processors are not in software P0 state.</p>                                                                                                                                                                                                                                                             |      |             |     |                             |         |                                |
| 1       | <p><b>TokenAllocSelect: Token allocation select.</b> Read-write. Reset: 0. BIOS: 0. 0=When both the MCT and GMC have less than their maximum outstanding tokens, tokens are allocated by alternating between each. 1= When both the MCT and GMC have less than their maximum outstanding tokens, tokens are allocated to whichever has less (DCQ entries + current outstanding).</p>                                                                                                                                                                                                                                                                                            |      |             |     |                             |         |                                |
| 0       | <p><b>CpuElevPrioDis: Cpu elevate priority disable.</b> Read-write. Reset: 0. BIOS: 0. 1=Reads from MCT arbitrate with GMC traffic normally. 0=Elevate the priority of a new MCT read to high if no other MCT reads currently exist in the DCQ. This can alleviate CPU stalls during very long graphics requests.</p>                                                                                                                                                                                                                                                                                                                                                           |      |             |     |                             |         |                                |

### D18F2x420\_dct[3:0] GMC to DCT FIFO Config 1

See [2.9.3 \[DCT Configuration Registers\]](#).

| Bits  | Description |
|-------|-------------|
| 31:12 | Reserved.   |
| 11:8  | Reserved.   |
| 7:4   | Reserved.   |
| 3:0   | Reserved.   |

### D18F2xB60\_dct[3:0] DRAM Control 0

Reset: 0000\_3010h.

| Bits | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:1 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 0    | <p><b>DataScrambleEn: data scramble enable.</b> Read-write; <a href="#">Same-for-all</a>. 1=Data scrambling enabled. Data stored in the DRAM will be scrambled. 0=Data scrambling disabled. This register must have the same value for all DCT's. This bit is valid for <a href="#">Ddr3Mode</a>. BIOS should set this bit prior to any memory write transactions to DRAM not generated by the DCT pattern generation logic.</p> <p>See <a href="#">D18F2x250_dct[3:0][CmdTestEnable]</a> for additional pattern generation requirements.</p> |

**D18F2xB64\_dct[3:0] Data Scramble Key**

---

Reset: 0000\_0000h. See [2.9.3 \[DCT Configuration Registers\]](#).

| Bits | Description                                                                                                                                                                               |
|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:0 | <b>DatScrambleKey:</b> data scramble key. Read-write; <a href="#">Same-for-all</a> . Specifies the key value used for data scrambling. This field is valid for <a href="#">Ddr3Mode</a> . |

### 3.12 Device 18h Function 3 Configuration Registers

See 3.1 [Register Descriptions and Mnemonics]. See 2.7 [Configuration Space].

#### D18F3x00 Device/Vendor ID

| Bits  | Description                                          |
|-------|------------------------------------------------------|
| 31:16 | <b>DeviceID:</b> device ID. Read-only. Value: 141Dh. |
| 15:0  | <b>VendorID:</b> vendor ID. Read-only. Value: 1022h. |

#### D18F3x04 Status/Command

| Bits  | Description                                                                                                                                        |
|-------|----------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:16 | <b>Status.</b> Read-only. Reset: 0000h, except bit[20]. Bit[20] is set to indicate the existence of a PCI-defined capability block, if one exists. |
| 15:0  | <b>Command.</b> Read-only. Reset: 0000h.                                                                                                           |

#### D18F3x08 Class Code/Revision ID

| Bits | Description                                                                                                           |
|------|-----------------------------------------------------------------------------------------------------------------------|
| 31:8 | <b>ClassCode.</b> Read-only. Reset: 060000h. Provides the host bridge class code as defined in the PCI specification. |
| 7:0  | <b>RevID:</b> revision ID. Read-only. Reset: 00h.                                                                     |

#### D18F3x0C Header Type

Reset: 0080\_0000h.

| Bits | Description                                                                                                                                                              |
|------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:0 | <b>HeaderTypeReg.</b> Read-only. These bits are fixed at their default values. The header type field indicates that there are multiple functions present in this device. |

#### D18F3x34 Capability Pointer

| Bits | Description                           |
|------|---------------------------------------|
| 31:8 | Reserved.                             |
| 7:0  | <b>CapPtr.</b> Read-only. Value: 00h. |

#### D18F3x40 MCA NB Control

Read-write. Reset: 0000\_0000h. [MSR0000\\_0410](#)[31:0] is an alias of [D18F3x40](#). See [MSR0000\\_0410](#)[31:0].

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31    | <b>McaCpuDatErrEn: Compute Unit data error.</b> 1=Enables MCA reporting of CPU data errors sent to the NB.                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| 30    | Unused.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 29:28 | Unused.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 27    | Unused.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 26    | <b>NbArrayParEn: northbridge array parity error reporting enable.</b> 1=Enables reporting of parity errors in the NB arrays.                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| 25    | <b>UsPwDatErrEn: upstream data error enable.</b> Read-write. 1=Enables MCA reporting of upstream posted writes in which the EP bit is set.                                                                                                                                                                                                                                                                                                                                                                                                                                |
| 24:18 | Unused.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 17    | <b>CpPktDatEn: completion packet error reporting enable.</b> Read-write. 1=Enables MCA reporting of completion packets with the EP bit set.                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 16    | <b>NbIntProtEn: northbridge internal bus protocol error reporting enable.</b> Read-write. 1=Enables MCA reporting of protocol errors detected on the northbridge internal bus. When possible, this enable should be cleared before initiating a warm reset to avoid logging spurious errors due to RESET_L signal skew.                                                                                                                                                                                                                                                   |
| 15:13 | Unused.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 12    | <b>WDTRptEn: watchdog timer error reporting enable.</b> 1=Enables MCA reporting of watchdog timer errors. The watchdog timer checks for NB system accesses for which a response is expected but no response is received. See <a href="#">D18F3x44 [MCA NB Configuration]</a> for information regarding configuration of the watchdog timer duration. This bit does not affect operation of the watchdog timer in terms of its ability to complete an access that would otherwise cause a system hang. This bit only affects whether such errors are reported through MCA. |
| 11    | <b>AtomicRMWEn: atomic read-modify-write error reporting enable.</b> 1=Enables MCA reporting of atomic read-modify-write (RMW) commands received from an IO link. Atomic RMW commands are not supported. An atomic RMW command results in a link error response being generated back to the requesting IO device. The generation of the link error response is not affected by this bit.                                                                                                                                                                                  |
| 10    | Unused.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 9     | <b>TgtAbortEn: target abort error reporting enable.</b> 1=Enables MCA reporting of target aborts to a link. The NB returns an error response back to the requestor with any associated data all 1s independent of the state of this bit.                                                                                                                                                                                                                                                                                                                                  |
| 8     | <b>MstrAbortEn: master abort error reporting enable.</b> 1=Enables MCA reporting of master aborts to a link. The NB returns an error response back to the requestor with any associated data all 1s independent of the state of this bit.                                                                                                                                                                                                                                                                                                                                 |
| 7:6   | Unused.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 5     | <b>SyncPktEn: link sync packet error reporting enable.</b> 1=Enables MCA reporting of link-defined sync error packets detected on link. The NB floods its outgoing link with sync packets after detecting a sync packet on the incoming link independent of the state of this bit.                                                                                                                                                                                                                                                                                        |



|     |                                                                                                                                                                                                                                                                                                           |
|-----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 4:2 | Unused.                                                                                                                                                                                                                                                                                                   |
| 1   | <b>UECCEn: uncorrectable ECC error reporting enable.</b> 1=Enables MCA reporting of DDR3 DRAM uncorrectable ECC errors which are detected in the NB. In some cases data may be forwarded to the core prior to checking ECC in which case the check takes place in one of the other error reporting banks. |
| 0   | <b>CECCEn: correctable ECC error reporting enable.</b> 1=Enables MCA reporting of DDR3 DRAM correctable ECC errors which are detected in the NB.                                                                                                                                                          |

### D18F3x44 MCA NB Configuration

See [D18F3x180 \[Extended NB MCA Configuration\]](#). It is expected that all fields of this register are programmed to the same value in all nodes, except for the fields used for link error injection: GenLinkSel, GenSubLinkSel, GenCrcErrByte1, GenCrcErrByte0.

| Bits | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31   | <b>NbMcaLogEn: northbridge MCA log enable.</b> Read-write. Reset: 0. 1=Enables logging (but not reporting) of NB MCA errors even if MCA is not globally enabled.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 30   | <b>SyncFloodOnDramAdrParErr: sync flood on DRAM address parity error.</b> Read-write. Reset: 0. BIOS: 1. 1=Enable sync flood on detection of a DRAM address parity error.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 29   | <b>DisMstAbortCpuErrRsp: master abort CPU error response disable.</b> Read-write. Reset: 0. 1=Disables master abort reporting through the CPU MCA error-reporting banks; Suppresses sending of RDE to CPU; Does not log any MCA information in the NB.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 28   | <b>DisTgtAbortCpuErrRsp: target abort CPU error response disable.</b> Read-write. Reset: 0. 1=Disables target abort reporting through the CPU MCA error-reporting banks; Suppresses sending of RDE to CPU; Does not log any MCA information in the NB.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 27   | <b>NbMcaToMstCpuEn: machine check errors to master CPU only.</b> Read-write. Reset: 0. BIOS: 1. 1=NB MCA errors in CMP device are only reported to the node base core (NBC), and the NB MCA registers in MSR space ( <a href="#">MSR0000_0410</a> , <a href="#">MSR0000_0411</a> , <a href="#">MSR0000_0412</a> , <a href="#">MSR0000_0413</a> , <a href="#">MSR0000_0408</a> , and <a href="#">MSRC001_0048</a> ) are only accessible from the NBC; reads of these MSRs from other cores return 0's and writes are ignored. This allows machine check handlers running on different cores to avoid coordinating accesses to the NB MCA registers. This field does not affect PCI-defined configuration space accesses to these registers, which are accessible from all cores. See <a href="#">3.1 [Register Descriptions and Mnemonics]</a> for a description of MSR space and <a href="#">3 [Registers]</a> for PCI-defined configuration space. 0=NB MCA errors may be reported to the core that originated the request, if applicable and known, and the NB MCA registers in MSR space are accessible from any core.<br>Note:<br><ul style="list-style-type: none"> <li>When the CPU which originated the request is known, it is stored in <a href="#">MSR0000_0411[ErrCoreId]</a>, regardless of the setting of NbMcaToMstCpuEn. See <a href="#">Table 232</a> for errors where ErrCoreId is known.</li> <li>If IO originated the request, then the error is reported to the NBC, regardless of the setting of NbMcaToMstCpuEn.</li> </ul> |
| 26   | <b>FlagMcaCorrErr: correctable error MCA exception enable.</b> Read-write. Reset: 0. 1=Raise a machine check exception for correctable and deferred machine check errors which are enabled in <a href="#">D18F3x40</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |

| 25          | <b>DisPciCfgCpuErrRsp: PCI configuration CPU error response disable.</b> Read-write. Reset: 0. 1=Disables generation of an error response to the core on detection of a master abort, target abort, or data error condition, and disables logging and reporting through the MCA error-reporting banks for PCI configuration accesses. For NB WDT errors on PCI configuration accesses, this prevents sending an error response to the core, but does not affect logging and reporting of the NB WDT error. See <a href="#">D18F3x180</a> [DisPciCfgCpuMstAbortRsp], which applies only to master aborts.                                                                            |             |                    |     |           |     |           |     |          |     |          |
|-------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|--------------------|-----|-----------|-----|-----------|-----|----------|-----|----------|
| 24          | <b>IoRdDatErrEn: IO read data error log enable.</b> Read-write. Reset: 0. 1=Enables MCA logging and reporting of errors on transactions from IO devices upon detection of a target abort, master abort, or data error condition. 0=Errors on transactions from IO devices are not logged in MCA, although error responses to the requesting IO device may still be generated.                                                                                                                                                                                                                                                                                                       |             |                    |     |           |     |           |     |          |     |          |
| 23          | <b>ChipKillEccCap: chip-kill ECC mode.</b> Read-only; updated-by-hardware. Reset: 0. 1=Chipkill ECC mode capable; ECC checking is based on x8 ECC symbols ( <a href="#">D18F3x180</a> [EccSymbolSize]) and can be used for chipkill. 0=Chipkill ECC mode not capable; ECC checking is based on two interleaved, unganged 64/8-bit data/ECC lines and x4 ECC symbols and cannot be used for chipkill. See <a href="#">2.15.2 [DRAM ECC Considerations]</a> .                                                                                                                                                                                                                         |             |                    |     |           |     |           |     |          |     |          |
| 22          | <b>DramEccEn: DRAM ECC enable.</b> Read-write. Reset: 0. 1=Enables ECC check/correct mode. This bit must be set in order for ECC checking/correcting by the NB to be enabled. If set, ECC is checked and correctable errors are corrected irrespective of whether machine check ECC reporting is enabled. The hardware only allows values to be programmed into this field which are consistent with the ECC capabilities of the device as specified in <a href="#">D18F3xE8 [Northbridge Capabilities]</a> . Attempts to write values inconsistent with the capabilities results in this field not being updated. This bit does not affect ECC checking in the northbridge arrays. |             |                    |     |           |     |           |     |          |     |          |
| 21          | <b>SyncFloodOnAnyUcErr: sync flood on any UC error.</b> Read-write. Reset: 0. BIOS: 1. 1=Enable sync flood of all links with sync packets on detection of any NB MCA error that is uncorrectable, including northbridge array errors and link protocol errors.                                                                                                                                                                                                                                                                                                                                                                                                                      |             |                    |     |           |     |           |     |          |     |          |
| 20          | <b>SyncFloodOnWDT: sync flood on watchdog timer error.</b> Read-write. Reset: 0. BIOS: 1. 1=Enable sync flood of all links with sync packets on detection of a watchdog timer error.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |             |                    |     |           |     |           |     |          |     |          |
| 19:18       | <p><b>GenSubLinkSel: sublink select for CRC error generation.</b> Read-write. Reset: 0. Selects the sublink of a link selected by GenLinkSel to be used for CRC error injection through GenCrcErrByte0 and GenCrcErrByte1. When the link is ganged, GenSubLinkSel must be 00b. When the link is unganged, the following values indicate which sublink is selected:</p> <table> <thead> <tr> <th><u>Bits</u></th><th><u>Description</u></th></tr> </thead> <tbody> <tr> <td>00b</td><td>Sublink 0</td></tr> <tr> <td>01b</td><td>Sublink 1</td></tr> <tr> <td>10b</td><td>Reserved</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </tbody> </table>                               | <u>Bits</u> | <u>Description</u> | 00b | Sublink 0 | 01b | Sublink 1 | 10b | Reserved | 11b | Reserved |
| <u>Bits</u> | <u>Description</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |             |                    |     |           |     |           |     |          |     |          |
| 00b         | Sublink 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |             |                    |     |           |     |           |     |          |     |          |
| 01b         | Sublink 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |             |                    |     |           |     |           |     |          |     |          |
| 10b         | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |             |                    |     |           |     |           |     |          |     |          |
| 11b         | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |             |                    |     |           |     |           |     |          |     |          |
| 17          | <b>GenCrcErrByte1: generate CRC error on byte lane 1.</b> Read-write. Reset: 0. 1=For ganged links (see GenSubLinkSel), a CRC error is injected on byte lane 1 of the link specified by GenLinkSel. For ganged links in retry mode or unganged links, this field is reserved, and GenCrcErrByte0 must be used. The data carried by the link is unaffected. This bit is cleared after the error has been generated.                                                                                                                                                                                                                                                                  |             |                    |     |           |     |           |     |          |     |          |
| 16          | <b>GenCrcErrByte0: generate CRC error on byte lane 0.</b> Read-write. Reset: 0. 1=Causes a CRC error to be injected on byte lane 0 of the link specified by GenLinkSel and the sublink specified by GenSubLinkSel. The data carried by the link is unaffected. This bit is cleared after the error has been generated.                                                                                                                                                                                                                                                                                                                                                              |             |                    |     |           |     |           |     |          |     |          |

| 15:14       | <p><b>GenLinkSel: link select for CRC error generation.</b> Read-write. Reset: 00b. Selects the link to be used for CRC error injection through GenCrcErrByte1/GenCrcErrByte0.</p> <table> <tr> <th><u>Bits</u></th><th><u>Description</u></th></tr> <tr> <td>00b</td><td>link 0</td></tr> <tr> <td>01b</td><td>link 1</td></tr> <tr> <td>10b</td><td>link 2</td></tr> <tr> <td>11b</td><td>link 3</td></tr> </table>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <u>Bits</u> | <u>Description</u> | 00b   | link 0  | 01b   | link 1  | 10b   | link 2    | 11b   | link 3    |       |     |       |     |       |    |       |    |       |      |       |       |             |          |
|-------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|--------------------|-------|---------|-------|---------|-------|-----------|-------|-----------|-------|-----|-------|-----|-------|----|-------|----|-------|------|-------|-------|-------------|----------|
| <u>Bits</u> | <u>Description</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |             |                    |       |         |       |         |       |           |       |           |       |     |       |     |       |    |       |    |       |      |       |       |             |          |
| 00b         | link 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |             |                    |       |         |       |         |       |           |       |           |       |     |       |     |       |    |       |    |       |      |       |       |             |          |
| 01b         | link 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |             |                    |       |         |       |         |       |           |       |           |       |     |       |     |       |    |       |    |       |      |       |       |             |          |
| 10b         | link 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |             |                    |       |         |       |         |       |           |       |           |       |     |       |     |       |    |       |    |       |      |       |       |             |          |
| 11b         | link 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |             |                    |       |         |       |         |       |           |       |           |       |     |       |     |       |    |       |    |       |      |       |       |             |          |
| 13:12       | <p><b>WDTBaseSel: watchdog timer time base select.</b> Read-write. Reset: 0. Selects the time base used by the watchdog timer. The counter selected by WDTCntSel determines the maximum count value in the time base selected by WDTBaseSel.</p> <table> <tr> <th><u>Bits</u></th><th><u>Description</u></th></tr> <tr> <td>00b</td><td>1.31 ms</td></tr> <tr> <td>01b</td><td>1.28 us</td></tr> <tr> <td>10b</td><td>Reserved.</td></tr> <tr> <td>11b</td><td>Reserved.</td></tr> </table>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <u>Bits</u> | <u>Description</u> | 00b   | 1.31 ms | 01b   | 1.28 us | 10b   | Reserved. | 11b   | Reserved. |       |     |       |     |       |    |       |    |       |      |       |       |             |          |
| <u>Bits</u> | <u>Description</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |             |                    |       |         |       |         |       |           |       |           |       |     |       |     |       |    |       |    |       |      |       |       |             |          |
| 00b         | 1.31 ms                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |             |                    |       |         |       |         |       |           |       |           |       |     |       |     |       |    |       |    |       |      |       |       |             |          |
| 01b         | 1.28 us                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |             |                    |       |         |       |         |       |           |       |           |       |     |       |     |       |    |       |    |       |      |       |       |             |          |
| 10b         | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |             |                    |       |         |       |         |       |           |       |           |       |     |       |     |       |    |       |    |       |      |       |       |             |          |
| 11b         | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |             |                    |       |         |       |         |       |           |       |           |       |     |       |     |       |    |       |    |       |      |       |       |             |          |
| 11:9        | <p><b>WDTCntSel[2:0]: watchdog timer count select bits[2:0].</b> Read-write. Reset: 0. Selects the count used by the watchdog timer. WDTCntSel = {D18F3x180[WDTCntSel[3]], D18F3x44[WDTCntSel[2:0]]}. The counter selected by WDTCntSel determines the maximum count value in the time base selected by WDTBaseSel. WDTCntSel is encoded as:</p> <table> <tr> <th><u>Bits</u></th><th><u>Description</u></th></tr> <tr> <td>0000b</td><td>4095</td></tr> <tr> <td>0001b</td><td>2047</td></tr> <tr> <td>0010b</td><td>1023</td></tr> <tr> <td>0011b</td><td>511</td></tr> <tr> <td>0100b</td><td>255</td></tr> <tr> <td>0101b</td><td>127</td></tr> <tr> <td>0110b</td><td>63</td></tr> <tr> <td>0111b</td><td>31</td></tr> <tr> <td>1000b</td><td>8191</td></tr> <tr> <td>1001b</td><td>16383</td></tr> <tr> <td>1111b-1010b</td><td>Reserved</td></tr> </table> <p>Because WDTCntSel is split between two registers, care must be taken when programming WDTCntSel to ensure that a reserved value is never used by the watchdog timer or undefined behavior could result.</p> | <u>Bits</u> | <u>Description</u> | 0000b | 4095    | 0001b | 2047    | 0010b | 1023      | 0011b | 511       | 0100b | 255 | 0101b | 127 | 0110b | 63 | 0111b | 31 | 1000b | 8191 | 1001b | 16383 | 1111b-1010b | Reserved |
| <u>Bits</u> | <u>Description</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |             |                    |       |         |       |         |       |           |       |           |       |     |       |     |       |    |       |    |       |      |       |       |             |          |
| 0000b       | 4095                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |             |                    |       |         |       |         |       |           |       |           |       |     |       |     |       |    |       |    |       |      |       |       |             |          |
| 0001b       | 2047                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |             |                    |       |         |       |         |       |           |       |           |       |     |       |     |       |    |       |    |       |      |       |       |             |          |
| 0010b       | 1023                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |             |                    |       |         |       |         |       |           |       |           |       |     |       |     |       |    |       |    |       |      |       |       |             |          |
| 0011b       | 511                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |             |                    |       |         |       |         |       |           |       |           |       |     |       |     |       |    |       |    |       |      |       |       |             |          |
| 0100b       | 255                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |             |                    |       |         |       |         |       |           |       |           |       |     |       |     |       |    |       |    |       |      |       |       |             |          |
| 0101b       | 127                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |             |                    |       |         |       |         |       |           |       |           |       |     |       |     |       |    |       |    |       |      |       |       |             |          |
| 0110b       | 63                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |             |                    |       |         |       |         |       |           |       |           |       |     |       |     |       |    |       |    |       |      |       |       |             |          |
| 0111b       | 31                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |             |                    |       |         |       |         |       |           |       |           |       |     |       |     |       |    |       |    |       |      |       |       |             |          |
| 1000b       | 8191                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |             |                    |       |         |       |         |       |           |       |           |       |     |       |     |       |    |       |    |       |      |       |       |             |          |
| 1001b       | 16383                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |             |                    |       |         |       |         |       |           |       |           |       |     |       |     |       |    |       |    |       |      |       |       |             |          |
| 1111b-1010b | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |             |                    |       |         |       |         |       |           |       |           |       |     |       |     |       |    |       |    |       |      |       |       |             |          |
| 8           | <p><b>WDTDis: watchdog timer disable.</b> Read-write. Cold reset: 0. 1=Disables the watchdog timer. The watchdog timer is enabled by default and checks for NB system accesses for which a response is expected and where no response is received. If such a condition is detected the outstanding access is completed by generating an error response back to the requestor. An MCA error may also be generated if enabled in D18F3x40 [MCA NB Control].</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |             |                    |       |         |       |         |       |           |       |           |       |     |       |     |       |    |       |    |       |      |       |       |             |          |
| 7           | <p><b>IoErrDis: IO error response disable.</b> Read-write. Reset: 0. 1=Disables setting either Error bit in link response packets to IO devices on detection of a target or master abort error condition.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |             |                    |       |         |       |         |       |           |       |           |       |     |       |     |       |    |       |    |       |      |       |       |             |          |
| 6           | <p><b>CpuErrDis: CPU error response disable.</b> Read-write. Reset: 0. BIOS: 1. 1=Disables generation of a read data error response to the core on detection of a target or master abort error condition.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |             |                    |       |         |       |         |       |           |       |           |       |     |       |     |       |    |       |    |       |      |       |       |             |          |
| 5           | <p><b>IoMstAbortDis: IO master abort error response disable.</b> Read-write. Reset: 0. 1=Signals target abort instead of master abort in link response packets to IO devices on detection of a master abort error condition. When IoMstAbortDis and D18F3x180[ChgMstAbortToNoErr] are both set, D18F3x180[ChgMstAbortToNoErr] takes precedence.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |             |                    |       |         |       |         |       |           |       |           |       |     |       |     |       |    |       |    |       |      |       |       |             |          |

|   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|---|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 4 | <b>SyncPktPropDis: sync packet propagation disable.</b> Read-write. Reset: 0. BIOS: 0. 1=Disables flooding of all outgoing links with sync packets when a sync packet is detected on an incoming link. Sync packets are propagated by default.                                                                                                                                                                                                                                  |
| 3 | <b>SyncPktGenDis: sync packet generation disable.</b> Read-write. Reset: 0. BIOS: 0. 1=Disables flooding of all outgoing links with sync packets when a CRC error is detected on an incoming link. By default, sync packet generation for CRC errors is controlled through <a href="#">D18F0x[E4,C4,A4,84]</a> [ <a href="#">Link Control</a> ].                                                                                                                                |
| 2 | <b>SyncFloodOnDramUcEcc: sync flood on uncorrectable DRAM ECC error.</b> Read-write. Reset: 0. BIOS: 1.<br>1=Enable sync flood of all links with sync packets on detection of an uncorrectable DRAM ECC error.                                                                                                                                                                                                                                                                  |
| 1 | <b>CpuRdDatErrEn: CPU read data error log enable.</b> Read-write. Reset: 0. 1=Enables reporting of read data errors (master aborts and target aborts) for data destined for the CPU on this node. This bit should be clear if read data error logging is enabled for the remaining error reporting blocks in the CPU. Logging the same error in more than one block may cause a single error event to be treated as a multiple error event and cause the CPU to enter shutdown. |
| 0 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |

#### D18F3x48 MCA NB Status Low

| Bits | Description                                                                                                      |
|------|------------------------------------------------------------------------------------------------------------------|
| 31:0 | <a href="#">MSR0000_0411</a> [31:0] is an alias of <a href="#">D18F3x48</a> . See <a href="#">MSR0000_0411</a> . |

#### D18F3x4C MCA NB Status High

| Bits | Description                                                                                                       |
|------|-------------------------------------------------------------------------------------------------------------------|
| 31:0 | <a href="#">MSR0000_0411</a> [63:32] is an alias of <a href="#">D18F3x4C</a> . See <a href="#">MSR0000_0411</a> . |

#### D18F3x50 MCA NB Address Low

| Bits | Description                                                                                                            |
|------|------------------------------------------------------------------------------------------------------------------------|
| 31:0 | <a href="#">MSR0000_0412</a> [31:0] is an alias of <a href="#">D18F3x50</a> . See <a href="#">MSR0000_0412</a> [31:0]. |

#### D18F3x54 MCA NB Address High

| Bits | Description                                                                                                              |
|------|--------------------------------------------------------------------------------------------------------------------------|
| 31:0 | <a href="#">MSR0000_0412</a> [63:32] is an alias of <a href="#">D18F3x54</a> . See <a href="#">MSR0000_0412</a> [63:32]. |

#### D18F3x58 Scrub Rate Control

This register specifies the ECC sequential scrubbing rate for lines of memory and cache. See 2.8.3 [[Memory Scrubbers](#)]. Scrub rates are a platform consideration. See 2.15.1.8 [[Scrub Rate Considerations](#)].

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |         |             |      |             |     |                              |     |         |     |                    |     |         |     |                    |     |         |     |                     |     |          |     |                     |     |          |     |        |     |       |     |         |     |       |     |         |         |          |     |         |     |          |     |         |  |  |     |         |  |  |     |         |  |  |     |         |  |  |     |          |  |  |     |          |  |  |     |          |  |  |
|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|-------------|------|-------------|-----|------------------------------|-----|---------|-----|--------------------|-----|---------|-----|--------------------|-----|---------|-----|---------------------|-----|----------|-----|---------------------|-----|----------|-----|--------|-----|-------|-----|---------|-----|-------|-----|---------|---------|----------|-----|---------|-----|----------|-----|---------|--|--|-----|---------|--|--|-----|---------|--|--|-----|---------|--|--|-----|----------|--|--|-----|----------|--|--|-----|----------|--|--|
| 31:29 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |         |             |      |             |     |                              |     |         |     |                    |     |         |     |                    |     |         |     |                     |     |          |     |                     |     |          |     |        |     |       |     |         |     |       |     |         |         |          |     |         |     |          |     |         |  |  |     |         |  |  |     |         |  |  |     |         |  |  |     |          |  |  |     |          |  |  |     |          |  |  |
| 28:24 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |         |             |      |             |     |                              |     |         |     |                    |     |         |     |                    |     |         |     |                     |     |          |     |                     |     |          |     |        |     |       |     |         |     |       |     |         |         |          |     |         |     |          |     |         |  |  |     |         |  |  |     |         |  |  |     |         |  |  |     |          |  |  |     |          |  |  |     |          |  |  |
| 23:5  | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |         |             |      |             |     |                              |     |         |     |                    |     |         |     |                    |     |         |     |                     |     |          |     |                     |     |          |     |        |     |       |     |         |     |       |     |         |         |          |     |         |     |          |     |         |  |  |     |         |  |  |     |         |  |  |     |         |  |  |     |          |  |  |     |          |  |  |     |          |  |  |
| 4:0   | <b>DramScrub: DRAM scrub rate.</b> Read-write. Reset: 00000b. Specifies time between 64 B scrub events. See <a href="#">D18F3x5C</a> and <a href="#">D18F3x60</a> . <table><tr><th>Bits</th><th>Description</th><th>Bits</th><th>Description</th></tr><tr><td>00h</td><td>Disable sequential scrubbing</td><td>10h</td><td>1.31 ms</td></tr><tr><td>01h</td><td>40 ns<sup>1</sup></td><td>11h</td><td>2.62 ms</td></tr><tr><td>02h</td><td>80 ns<sup>1</sup></td><td>12h</td><td>5.24 ms</td></tr><tr><td>03h</td><td>160 ns<sup>1</sup></td><td>13h</td><td>10.49 ms</td></tr><tr><td>04h</td><td>320 ns<sup>1</sup></td><td>14h</td><td>20.97 ms</td></tr><tr><td>05h</td><td>640 ns</td><td>15h</td><td>42 ms</td></tr><tr><td>06h</td><td>1.28 us</td><td>16h</td><td>84 ms</td></tr><tr><td>07h</td><td>2.56 us</td><td>1Eh-17h</td><td>Reserved</td></tr><tr><td>08h</td><td>5.12 us</td><td>1Fh</td><td>Reserved</td></tr><tr><td>09h</td><td>10.2 us</td><td></td><td></td></tr><tr><td>0Ah</td><td>20.5 us</td><td></td><td></td></tr><tr><td>0Bh</td><td>41.0 us</td><td></td><td></td></tr><tr><td>0Ch</td><td>81.9 us</td><td></td><td></td></tr><tr><td>0Dh</td><td>163.8 us</td><td></td><td></td></tr><tr><td>0Eh</td><td>327.7 us</td><td></td><td></td></tr><tr><td>0Fh</td><td>655.4 us</td><td></td><td></td></tr></table> Note: <ol style="list-style-type: none"><li>1. This setting is not supported except as a DRAM scrub rate when no other memory accesses are being performed.</li></ol> | Bits    | Description | Bits | Description | 00h | Disable sequential scrubbing | 10h | 1.31 ms | 01h | 40 ns <sup>1</sup> | 11h | 2.62 ms | 02h | 80 ns <sup>1</sup> | 12h | 5.24 ms | 03h | 160 ns <sup>1</sup> | 13h | 10.49 ms | 04h | 320 ns <sup>1</sup> | 14h | 20.97 ms | 05h | 640 ns | 15h | 42 ms | 06h | 1.28 us | 16h | 84 ms | 07h | 2.56 us | 1Eh-17h | Reserved | 08h | 5.12 us | 1Fh | Reserved | 09h | 10.2 us |  |  | 0Ah | 20.5 us |  |  | 0Bh | 41.0 us |  |  | 0Ch | 81.9 us |  |  | 0Dh | 163.8 us |  |  | 0Eh | 327.7 us |  |  | 0Fh | 655.4 us |  |  |
| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Bits    | Description |      |             |     |                              |     |         |     |                    |     |         |     |                    |     |         |     |                     |     |          |     |                     |     |          |     |        |     |       |     |         |     |       |     |         |         |          |     |         |     |          |     |         |  |  |     |         |  |  |     |         |  |  |     |         |  |  |     |          |  |  |     |          |  |  |     |          |  |  |
| 00h   | Disable sequential scrubbing                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 10h     | 1.31 ms     |      |             |     |                              |     |         |     |                    |     |         |     |                    |     |         |     |                     |     |          |     |                     |     |          |     |        |     |       |     |         |     |       |     |         |         |          |     |         |     |          |     |         |  |  |     |         |  |  |     |         |  |  |     |         |  |  |     |          |  |  |     |          |  |  |     |          |  |  |
| 01h   | 40 ns <sup>1</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 11h     | 2.62 ms     |      |             |     |                              |     |         |     |                    |     |         |     |                    |     |         |     |                     |     |          |     |                     |     |          |     |        |     |       |     |         |     |       |     |         |         |          |     |         |     |          |     |         |  |  |     |         |  |  |     |         |  |  |     |         |  |  |     |          |  |  |     |          |  |  |     |          |  |  |
| 02h   | 80 ns <sup>1</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 12h     | 5.24 ms     |      |             |     |                              |     |         |     |                    |     |         |     |                    |     |         |     |                     |     |          |     |                     |     |          |     |        |     |       |     |         |     |       |     |         |         |          |     |         |     |          |     |         |  |  |     |         |  |  |     |         |  |  |     |         |  |  |     |          |  |  |     |          |  |  |     |          |  |  |
| 03h   | 160 ns <sup>1</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 13h     | 10.49 ms    |      |             |     |                              |     |         |     |                    |     |         |     |                    |     |         |     |                     |     |          |     |                     |     |          |     |        |     |       |     |         |     |       |     |         |         |          |     |         |     |          |     |         |  |  |     |         |  |  |     |         |  |  |     |         |  |  |     |          |  |  |     |          |  |  |     |          |  |  |
| 04h   | 320 ns <sup>1</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 14h     | 20.97 ms    |      |             |     |                              |     |         |     |                    |     |         |     |                    |     |         |     |                     |     |          |     |                     |     |          |     |        |     |       |     |         |     |       |     |         |         |          |     |         |     |          |     |         |  |  |     |         |  |  |     |         |  |  |     |         |  |  |     |          |  |  |     |          |  |  |     |          |  |  |
| 05h   | 640 ns                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 15h     | 42 ms       |      |             |     |                              |     |         |     |                    |     |         |     |                    |     |         |     |                     |     |          |     |                     |     |          |     |        |     |       |     |         |     |       |     |         |         |          |     |         |     |          |     |         |  |  |     |         |  |  |     |         |  |  |     |         |  |  |     |          |  |  |     |          |  |  |     |          |  |  |
| 06h   | 1.28 us                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 16h     | 84 ms       |      |             |     |                              |     |         |     |                    |     |         |     |                    |     |         |     |                     |     |          |     |                     |     |          |     |        |     |       |     |         |     |       |     |         |         |          |     |         |     |          |     |         |  |  |     |         |  |  |     |         |  |  |     |         |  |  |     |          |  |  |     |          |  |  |     |          |  |  |
| 07h   | 2.56 us                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 1Eh-17h | Reserved    |      |             |     |                              |     |         |     |                    |     |         |     |                    |     |         |     |                     |     |          |     |                     |     |          |     |        |     |       |     |         |     |       |     |         |         |          |     |         |     |          |     |         |  |  |     |         |  |  |     |         |  |  |     |         |  |  |     |          |  |  |     |          |  |  |     |          |  |  |
| 08h   | 5.12 us                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 1Fh     | Reserved    |      |             |     |                              |     |         |     |                    |     |         |     |                    |     |         |     |                     |     |          |     |                     |     |          |     |        |     |       |     |         |     |       |     |         |         |          |     |         |     |          |     |         |  |  |     |         |  |  |     |         |  |  |     |         |  |  |     |          |  |  |     |          |  |  |     |          |  |  |
| 09h   | 10.2 us                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |         |             |      |             |     |                              |     |         |     |                    |     |         |     |                    |     |         |     |                     |     |          |     |                     |     |          |     |        |     |       |     |         |     |       |     |         |         |          |     |         |     |          |     |         |  |  |     |         |  |  |     |         |  |  |     |         |  |  |     |          |  |  |     |          |  |  |     |          |  |  |
| 0Ah   | 20.5 us                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |         |             |      |             |     |                              |     |         |     |                    |     |         |     |                    |     |         |     |                     |     |          |     |                     |     |          |     |        |     |       |     |         |     |       |     |         |         |          |     |         |     |          |     |         |  |  |     |         |  |  |     |         |  |  |     |         |  |  |     |          |  |  |     |          |  |  |     |          |  |  |
| 0Bh   | 41.0 us                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |         |             |      |             |     |                              |     |         |     |                    |     |         |     |                    |     |         |     |                     |     |          |     |                     |     |          |     |        |     |       |     |         |     |       |     |         |         |          |     |         |     |          |     |         |  |  |     |         |  |  |     |         |  |  |     |         |  |  |     |          |  |  |     |          |  |  |     |          |  |  |
| 0Ch   | 81.9 us                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |         |             |      |             |     |                              |     |         |     |                    |     |         |     |                    |     |         |     |                     |     |          |     |                     |     |          |     |        |     |       |     |         |     |       |     |         |         |          |     |         |     |          |     |         |  |  |     |         |  |  |     |         |  |  |     |         |  |  |     |          |  |  |     |          |  |  |     |          |  |  |
| 0Dh   | 163.8 us                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |         |             |      |             |     |                              |     |         |     |                    |     |         |     |                    |     |         |     |                     |     |          |     |                     |     |          |     |        |     |       |     |         |     |       |     |         |         |          |     |         |     |          |     |         |  |  |     |         |  |  |     |         |  |  |     |         |  |  |     |          |  |  |     |          |  |  |     |          |  |  |
| 0Eh   | 327.7 us                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |         |             |      |             |     |                              |     |         |     |                    |     |         |     |                    |     |         |     |                     |     |          |     |                     |     |          |     |        |     |       |     |         |     |       |     |         |         |          |     |         |     |          |     |         |  |  |     |         |  |  |     |         |  |  |     |         |  |  |     |          |  |  |     |          |  |  |     |          |  |  |
| 0Fh   | 655.4 us                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |         |             |      |             |     |                              |     |         |     |                    |     |         |     |                    |     |         |     |                     |     |          |     |                     |     |          |     |        |     |       |     |         |     |       |     |         |         |          |     |         |     |          |     |         |  |  |     |         |  |  |     |         |  |  |     |         |  |  |     |          |  |  |     |          |  |  |     |          |  |  |

### D18F3x5C DRAM Scrub Address Low

In addition to sequential DRAM scrubbing, the DRAM scrubber has a redirect mode for scrubbing DRAM locations accessed during normal operation. This is enabled by setting [D18F3x5C](#)[ScrubReDirEn]. When a DRAM read is generated by any agent other than the DRAM scrubber, correctable ECC errors are corrected as the data is passed to the requestor, but the data in DRAM is not corrected if redirect scrubbing mode is disabled. In scrubber redirect mode, correctable errors detected during normal DRAM read accesses redirect the scrubber to the location of the error. After the scrubber corrects the location in DRAM, it resumes scrubbing from where it left off. DRAM scrub address registers are not modified by the redirect scrubbing mode. Sequential scrubbing and scrubber redirection can be enabled independently or together. ECC errors detected by the scrubber are logged in the MCA registers (See [D18F3x40](#) [MCA NB Control]).

| Bits | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:6 | <b>ScrubAddr[31:6]: DRAM scrubber address bits[31:6].</b> Read-write; updated-by-hardware. ScrubAddr[47:6] = {D18F3x60[ScrubAddr[47:32]], ScrubAddr[31:6]}. Reset: 0. ScrubAddr points to a DRAM cacheline in physical address space. BIOS should initialize the scrubber address register to the base address of the node specified by D18F1x[17C:140,7C:40] [DRAM Base/Limit] prior to enabling sequential scrubbing through D18F3x58[DramScrub]. When sequential scrubbing is enabled: it starts at the address that the scrubber address registers are initialized to; it increments through address space and updates the scrubber address registers as it does so; when the scrubber reaches the DRAM limit address specified by D18F1x[17C:140,7C:40], it wraps around to the base address. Reads of the scrubber address registers provide the next cacheline to be scrubbed. |
| 5:1  | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| 0    | <b>ScrubReDirEn: DRAM scrubber redirect enable.</b> Read-write. Reset: 0. If a correctable error is discovered from a non-scrubber DRAM read, then the data is corrected before it is returned to the requestor; however, the DRAM location may be left in a corrupted state (until the next time the scrubber address counts up to that location, if sequential scrubbing is enabled through D18F3x58[DramScrub]). 1=Enables the scrubber to immediately scrub any address in which a correctable error is discovered. This bit and sequential scrubbing can be enabled independently or together; if both are enabled, the scrubber jumps from the scrubber address to where the correctable error was discovered, scrubs that location, and then jumps back to where it left off; the scrubber address register is not affected during scrubber redirection.                       |

### D18F3x60 DRAM Scrub Address High

| Bits  | Description                                                                                           |
|-------|-------------------------------------------------------------------------------------------------------|
| 31:16 | Reserved.                                                                                             |
| 15:0  | <b>ScrubAddr[47:32]: DRAM scrubber address bits[47:32].</b> See: D18F3x5C[ScrubAddr[31:6]]. Reset: 0. |

### D18F3x64 Hardware Thermal Control (HTC)

See 2.10.3.1 [PROCHOT\_L and Hardware Thermal Control (HTC)]. If D18F3xE8[HtcCapable]=0 then this register is reserved.

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31    | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| 30:28 | <b>HtcPstateLimit: HTC P-state limit select.</b> Read-write. Reset: Product-specific. Specifies the P-state limit of all cores when in the HTC-active state. This field uses hardware P-state numbering and is not changed on a write if the value written is greater than D18F3xDC[HwPstateMaxVal] or less than D18F4x15C[NumBoostStates]. See 2.10.3.1 [PROCHOT_L and Hardware Thermal Control (HTC)] and 2.5.3.1.1.2 [Hardware P-state Numbering]. |

| 27:24   | <b>HtcHystLmt: HTC hysteresis.</b> Read-write. Reset: Product-specific. The processor exits the HTC-active state when $(Tctl < (HtcTmpLmt - HtcHystLmt))$ .<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>0h</td><td>0</td></tr> <tr> <td>1h</td><td>0.5</td></tr> <tr> <td>Eh-2h</td><td><math>&lt;HtcHystLmt * 0.5&gt;</math></td></tr> <tr> <td>Fh</td><td>7.5</td></tr> </table>                                                                                                                                  | Bits | Description | 0h  | 0  | 1h  | 0.5  | Eh-2h   | $<HtcHystLmt * 0.5>$       | Fh  | 7.5   |
|---------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|-----|----|-----|------|---------|----------------------------|-----|-------|
| Bits    | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |      |             |     |    |     |      |         |                            |     |       |
| 0h      | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |      |             |     |    |     |      |         |                            |     |       |
| 1h      | 0.5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |      |             |     |    |     |      |         |                            |     |       |
| Eh-2h   | $<HtcHystLmt * 0.5>$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |      |             |     |    |     |      |         |                            |     |       |
| Fh      | 7.5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |      |             |     |    |     |      |         |                            |     |       |
| 23      | <b>HtcSlewSel: HTC slew-controlled temperature select.</b> Read-write. Reset: 0. 1=HTC logic is driven by the slew-controlled temperature, Tctl, specified in <a href="#">D18F3xA4 [Reported Temperature Control]</a> . 0=HTC logic is driven by the measured control temperature with no slew controls.                                                                                                                                                                                                                                |      |             |     |    |     |      |         |                            |     |       |
| 22:16   | <b>HtcTmpLmt: HTC temperature limit.</b> Read-write. Reset: Product-specific. The processor enters the HTC-active state when Tctl reaches or exceeds the temperature limit defined by this register.<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00h</td><td>52</td></tr> <tr> <td>01h</td><td>52.5</td></tr> <tr> <td>7Eh-02h</td><td><math>&lt;(HtcTmpLmt * 0.5) + 52&gt;</math></td></tr> <tr> <td>7Fh</td><td>115.5</td></tr> </table>                                                                          | Bits | Description | 00h | 52 | 01h | 52.5 | 7Eh-02h | $<(HtcTmpLmt * 0.5) + 52>$ | 7Fh | 115.5 |
| Bits    | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |      |             |     |    |     |      |         |                            |     |       |
| 00h     | 52                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |      |             |     |    |     |      |         |                            |     |       |
| 01h     | 52.5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |      |             |     |    |     |      |         |                            |     |       |
| 7Eh-02h | $<(HtcTmpLmt * 0.5) + 52>$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |      |             |     |    |     |      |         |                            |     |       |
| 7Fh     | 115.5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |      |             |     |    |     |      |         |                            |     |       |
| 15:8    | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |      |             |     |    |     |      |         |                            |     |       |
| 7       | <b>PslApicLoEn: P-state limit lower value change APIC interrupt enable.</b> Read-write. Reset: 0. PslApicLoEn and PslApicHiEn enable interrupts using <a href="#">APIC330 [LVT Thermal Sensor]</a> of each core when the active P-state limit in <a href="#">MSRC001_0061 [CurPstateLimit]</a> changes. PslApicLoEn enables the interrupt when the limit value becomes lower (indicating higher performance). PslApicHiEn enables the interrupt when the limit value becomes higher (indicating lower performance). 1=Enable interrupt. |      |             |     |    |     |      |         |                            |     |       |
| 6       | <b>PslApicHiEn: P-state limit higher value change APIC interrupt enable.</b> Read-write. Reset: 0. See PslApicLoEn.                                                                                                                                                                                                                                                                                                                                                                                                                     |      |             |     |    |     |      |         |                            |     |       |
| 5       | <b>HtcActSts: HTC-active status.</b> Read; set-by-hardware; write-1-to-clear. Reset: 0. This bit is set by hardware when the processor enters the HTC-active state. It is cleared by writing a 1 to it.                                                                                                                                                                                                                                                                                                                                 |      |             |     |    |     |      |         |                            |     |       |
| 4       | <b>HtcAct: HTC-active state.</b> Read-only, updated-by-hardware. Reset: X. . 1=The processor is currently in the HTC-active state. 0=The processor is not in the HTC-active state.                                                                                                                                                                                                                                                                                                                                                      |      |             |     |    |     |      |         |                            |     |       |
| 3:1     | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |      |             |     |    |     |      |         |                            |     |       |
| 0       | <b>HtcEn: HTC enable.</b> Read-write. Reset: 0. BIOS: IF ( <a href="#">D18F3x64 [HtcTmpLmt]</a> ==0) THEN 0 ELSE 1 ENDIF. 1=HTC is enabled; the processor is capable of entering the HTC-active state.                                                                                                                                                                                                                                                                                                                                  |      |             |     |    |     |      |         |                            |     |       |

### D18F3x68 Software P-state Limit

See [2.10.3.2 \[Software P-state Limit Control\]](#). If [D18F3xE8 \[HtcCapable\]](#)=0 then this register is reserved.

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                             |
|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31    | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                               |
| 30:28 | <b>SwPstateLimit: software P-state limit select.</b> Read-write. Reset: Product-specific. Specifies a P-state limit for all cores. Uses hardware P-state numbering; see <a href="#">2.5.3.1.1.2 [Hardware P-state Numbering]</a> . Not changed on a write if the value written is greater than <a href="#">D18F3xDC [HwPstateMaxVal]</a> or less than <a href="#">D18F4x15C [NumBoostStates]</a> . See SwPstateLimitEn. |
| 27:6  | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                               |



|     |                                                                                                          |
|-----|----------------------------------------------------------------------------------------------------------|
| 5   | <b>SwPstateLimitEn: software P-state limit enable.</b> Read-write. Reset: 0. 1=SwPstateLimit is enabled. |
| 4:0 | Reserved.                                                                                                |

### D18F3x6C Data Buffer Count

Out of cold reset, the processor allocates a minimal number of buffers that is smaller than the default values in the register. BIOS must use [D18F0x6C\[RlsLnkFullTokCntImm\]](#) for the values in the register to take effect. This is necessary even if the values are unchanged from the default values.

- To ensure deadlock free operation the following minimum buffer allocations are required:
  - [D18F3x6C\[UpRspDBC\]](#)  $\geq 1$ .
  - [D18F3x6C\[DnReqDBC\]](#)  $\geq 1$ .
  - [D18F3x6C\[UpReqDBC\]](#)  $\geq 1$ .
  - [D18F3x6C\[DnRspDBC\]](#)  $\geq 1$ .
- If [D18F0x\[E4,C4,A4,84\]\[IsocEn\]](#)=1: [IsocRspDBC](#)  $\geq 1$ .
- The total number of data buffers allocated in this register and [D18F3x7C](#) must satisfy the following equation:
 
$$\begin{aligned} & \text{D18F3x6C[UpReqDBC]} + \text{D18F3x6C[UpRspDBC]} + \text{D18F3x6C[DnReqDBC]} + \\ & \text{D18F3x6C[DnRspDBC]} + \text{D18F3x6C[IsocRspDBC]} + (\text{IF } (\text{D18F3x7C[Sri2XbarFreeRspDBC]}==0) \\ & \text{THEN } (\text{D18F3x7C[Sri2XbarFreeXreqDBC]}*2) \text{ ELSE } \text{D18F3x7C[Sri2XbarFreeXreqDBC]} \text{ ENDIF}) + \\ & \text{D18F3x7C[Sri2XbarFreeRspDBC]} \leq 16. \end{aligned}$$

| Bits  | Description                                                                                    |
|-------|------------------------------------------------------------------------------------------------|
| 31    | Reserved.                                                                                      |
| 30:28 | <b>IsocRspDBC: isochronous response data buffer count.</b> Read-write. Cold reset: 3. BIOS: 1. |
| 27:19 | Reserved.                                                                                      |
| 18:16 | <b>UpRspDBC: upstream response data buffer count.</b> Read-write. Cold reset: 2. BIOS: 1.      |
| 15    | Reserved.                                                                                      |
| 14:8  | Reserved.                                                                                      |
| 7:6   | <b>DnRspDBC: downstream response data buffer count.</b> Read-write. Cold reset: 2. BIOS: 1.    |
| 5:4   | <b>DnReqDBC: downstream request data buffer count.</b> Read-write. Cold reset: 1. BIOS: 1.     |
| 3     | Reserved.                                                                                      |
| 2:0   | <b>UpReqDBC: upstream request data buffer count.</b> Read-write. Cold reset: 2. BIOS: 2.       |

### D18F3x70 SRI to XBAR Command Buffer Count

Out of cold reset, the processor allocates a minimal number of buffers that is smaller than the default values in the register. BIOS must use [D18F0x6C\[RlsLnkFullTokCntImm\]](#) for the values in the register to take effect. This is necessary even if the values are unchanged from the default values.

- To ensure deadlock free operation the following minimum buffer allocations are required:
  - [D18F3x70\[UpRspCBC\]](#)  $\geq 1$ .
  - [D18F3x70\[UpPreqCBC\]](#)  $\geq 1$ .
  - [D18F3x70\[DnPreqCBC\]](#)  $\geq 1$ .
  - [D18F3x70\[UpReqCBC\]](#)  $\geq 1$ .
  - [D18F3x70\[DnReqCBC\]](#)  $\geq 1$ .
  - [D18F3x70\[DnRspCBC\]](#)  $\geq 1$ .
- If any of the [D18F0x\[E4,C4,A4,84\]\[IsocEn\]](#) bits are set:



IsocReqCBC >= 1                      IsocRspCBC >= 1

- If **D18F0x[E4,C4,A4,84]**[IsocEn]=1 and isochronous posted requests may be generated by the system:

IsocPreqCBC >= 1

- The total number of SRI to XBAR commandbuffers allocated in this register and **D18F3x7C** must satisfy the following equation:

$$\begin{aligned} & \bullet \text{D18F3x70[IsocRspCBC]} + \text{D18F3x70[IsocPreqCBC]} + \text{D18F3x70[IsocReqCBC]} + \\ & \text{D18F3x70[UpRspCBC]} + \text{D18F3x70[DnPreqCBC]} + \text{D18F3x70[UpPreqCBC]} + \\ & \text{D18F3x70[DnReqCBC]} + \text{D18F3x70[DnRspCBC]} + \text{D18F3x70[UpReqCBC]} + \\ & \text{D18F3x7C[Sri2XbarFreeRspCBC]} + \text{D18F3x7C[Sri2XbarFreeXreqCBC]} \leq 48. \end{aligned}$$

| Bits  | Description                                                                                           |
|-------|-------------------------------------------------------------------------------------------------------|
| 31    | Reserved.                                                                                             |
| 30:28 | <b>IsocRspCBC: isoc response command buffer count.</b> Read-write. Cold reset: 1. BIOS: 1.            |
| 27    | Reserved.                                                                                             |
| 26:24 | <b>IsocPreqCBC: isoc posted request command buffer count.</b> Read-write. Cold reset: 1. BIOS: 0.     |
| 23    | Reserved.                                                                                             |
| 22:20 | <b>IsocReqCBC: isoc request command buffer count.</b> Read-write. Cold reset: 1. BIOS: 1.             |
| 19    | Reserved.                                                                                             |
| 18:16 | <b>UpRspCBC: upstream response command buffer count.</b> Read-write. Cold reset: 1. BIOS: 7.          |
| 15    | Reserved.                                                                                             |
| 14:12 | <b>DnPreqCBC: downstream posted request command buffer count.</b> Read-write. Cold reset: 2. BIOS: 1. |
| 11    | Reserved.                                                                                             |
| 10:8  | <b>UpPreqCBC: upstream posted request command buffer count.</b> Read-write. Cold reset: 1. BIOS: 1.   |
| 7:6   | <b>DnRspCBC: downstream response command buffer count.</b> Read-write. Cold reset: 1. BIOS: 1.        |
| 5:4   | <b>DnReqCBC: downstream request command buffer count.</b> Read-write. Cold reset: 1. BIOS: 1.         |
| 3     | Reserved.                                                                                             |
| 2:0   | <b>UpReqCBC: upstream request command buffer count.</b> Read-write. Cold reset: 3. BIOS: 7            |

### D18F3x74 XBAR to SRI Command Buffer Count

Cold reset: 0007\_1111h. Out of cold reset, the processor allocates a minimal number of buffers that is smaller than the default values in the register. BIOS must use **D18F0x6C**[RlsLnkFullTokCntImm] for the values in the register to take effect. This is necessary even if the values are unchanged from the default values.

**Table 184: Buffer Definitions**

| Term           | Definition                                                                |
|----------------|---------------------------------------------------------------------------|
| <b>SpqSize</b> | Probe command queue size.<br>SpqSize = 20.                                |
| <b>SrqSize</b> | SRQ (XBAR command and probe response to SRI) queue size.<br>SrqSize = 52. |

**Table 184: Buffer Definitions**

| Term            | Definition                                                 |
|-----------------|------------------------------------------------------------|
| <b>PrbRsp</b>   | SRQ entries hard allocated to probe responses. PrbRsp = 4. |
| <b>MpbcSize</b> | MPB command buffer size.<br>MpbcSize = 48.                 |
| <b>McqSize</b>  | MCT command queue size.<br>McqSize = 72.                   |

- To ensure deadlock free operation the following minimum buffer allocations are required:
  - $D18F3x74[ProbeCBC] \geq 2$ .
  - $D18F3x74[UpReqCBC] \geq 1$ .
  - $D18F3x74[UpPreqCBC] \geq 1$ .
  - $(IsocReqCBC + IsocPreqCBC + DRReqCBC) \leq 31$ .
  - $(IsocReqCBC + IsocPreqCBC + DRReqCBC) \leq (McqSize - 16)$ .
- If any of  $D18F0x[E4,C4,A4,84][IsocEn]$  bits are set, then  $IsocReqCBC \geq 1$ .
- If any of the  $D18F0x[E4,C4,A4,84][IsocEn]$  bits are set and isochronous posted requests may be generated by the system:  
 $IsocPreqCBC \geq 1$
- The total number of XBAR to SRI commandbuffers allocated in this register and  $D18F3x7C$  must satisfy the following equation:
  - $D18F3x74[UpReqCBC] + D18F3x74[UpPreqCBC] + D18F3x74[DnReqCBC] + D18F3x74[DnPreqCBC] + D18F3x74[IsocReqCBC] + D18F3x74[IsocPreqCBC] + D18F3x74[DRReqCBC] + D18F3x7C[Xbar2SriFreeListCBC] + (D18F3x1A0[CpuCmdBufCnt] * NumOfCompUnits) + D18F3x1A0[CpuToNbFreeBufCnt] + PrbRsp \leq SrqSize$
- The total number of SPQ (probe command) buffers allocated must satisfy the following equation:
  - $(D18F3x17C[SPQPrbFreeCBC] + D18F3x74[ProbeCBC]) \leq SpqSize$ .

| Bits  | Description                                                                                                                                                                                                                                                                     |      |             |    |           |       |                    |       |           |
|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|----|-----------|-------|--------------------|-------|-----------|
| 31:28 | <b>DRReqCBC: display refresh request command buffer count.</b> Read-write. BIOS: 0.                                                                                                                                                                                             |      |             |    |           |       |                    |       |           |
| 27    | Reserved.                                                                                                                                                                                                                                                                       |      |             |    |           |       |                    |       |           |
| 26:24 | <b>IsocPreqCBC: isochronous posted request command buffer count.</b> Read-write. BIOS: 1.                                                                                                                                                                                       |      |             |    |           |       |                    |       |           |
| 23:20 | <b>IsocReqCBC: isochronous request command buffer count.</b> Read-write. BIOS: 1.                                                                                                                                                                                               |      |             |    |           |       |                    |       |           |
| 19:16 | <b>ProbeCBC: probe command buffer count.</b> Read-write. BIOS: Ch.<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>0h</td><td>0 buffers</td></tr> <tr> <td>Ch-1h</td><td>&lt;ProbeCBC&gt; buffers</td></tr> <tr> <td>Fh-Dh</td><td>Reserved.</td></tr> </table> | Bits | Description | 0h | 0 buffers | Ch-1h | <ProbeCBC> buffers | Fh-Dh | Reserved. |
| Bits  | Description                                                                                                                                                                                                                                                                     |      |             |    |           |       |                    |       |           |
| 0h    | 0 buffers                                                                                                                                                                                                                                                                       |      |             |    |           |       |                    |       |           |
| Ch-1h | <ProbeCBC> buffers                                                                                                                                                                                                                                                              |      |             |    |           |       |                    |       |           |
| Fh-Dh | Reserved.                                                                                                                                                                                                                                                                       |      |             |    |           |       |                    |       |           |
| 15    | Reserved.                                                                                                                                                                                                                                                                       |      |             |    |           |       |                    |       |           |

|       |                                                                                           |
|-------|-------------------------------------------------------------------------------------------|
| 14:12 | <b>DnPreqCBC: downstream posted request command buffer count.</b> Read-write.<br>BIOS: 0. |
| 11    | Reserved.                                                                                 |
| 10:8  | <b>UpPreqCBC: upstream posted request command buffer count.</b> Read-write.<br>BIOS: 1.   |
| 7     | Reserved.                                                                                 |
| 6:4   | <b>DnReqCBC: downstream request command buffer count.</b> Read-write.<br>BIOS: 0.         |
| 3     | Reserved.                                                                                 |
| 2:0   | <b>UpReqCBC: upstream request command buffer count.</b> Read-write.<br>BIOS: 1.           |

### D18F3x78 MCT to XBAR Buffer Count

Cold Reset: 0024\_0519h. Out of cold reset, the processor allocates a minimal number of buffers that is smaller than the default values in the register. BIOS must use [D18F0x6C\[RlsLnkFullTokCntImm\]](#) for the values in the register to take effect. This is necessary even if the values are unchanged from the default values.

- To ensure deadlock free operation the following minimum buffer allocations are required:  
 $\text{ProbeCBC} \geq 1$                        $\text{RspCBC} \geq 1$                        $\text{RspDBC} \geq 2$   
 $\text{RspDBC} \geq \text{D18F2x11C}[\text{MctPrefReqLimit}] + 2$
- The total number of command buffers allocated in this register must satisfy the following equation:  
 $(\text{D18F3x78}[\text{ProbeCBC}] + \text{D18F3x78}[\text{RspCBC}]) \leq \text{MpbcsSize}.$

| Bits    | Description                                                                                                                                                                                                                                                                                                                                                           |      |             |         |          |     |           |         |                  |     |            |         |          |
|---------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|---------|----------|-----|-----------|---------|------------------|-----|------------|---------|----------|
| 31:22   | Reserved.                                                                                                                                                                                                                                                                                                                                                             |      |             |         |          |     |           |         |                  |     |            |         |          |
| 21:16   | <b>RspDBC: response data buffer count.</b> Read-write. BIOS: 20h<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>01h-00h</td><td>Reserved</td></tr> <tr> <td>02h</td><td>2 Buffers</td></tr> <tr> <td>1Fh-03h</td><td>&lt;RspDBC&gt; Buffers</td></tr> <tr> <td>20h</td><td>32 Buffers</td></tr> <tr> <td>3Fh-21h</td><td>Reserved</td></tr> </table> | Bits | Description | 01h-00h | Reserved | 02h | 2 Buffers | 1Fh-03h | <RspDBC> Buffers | 20h | 32 Buffers | 3Fh-21h | Reserved |
| Bits    | Description                                                                                                                                                                                                                                                                                                                                                           |      |             |         |          |     |           |         |                  |     |            |         |          |
| 01h-00h | Reserved                                                                                                                                                                                                                                                                                                                                                              |      |             |         |          |     |           |         |                  |     |            |         |          |
| 02h     | 2 Buffers                                                                                                                                                                                                                                                                                                                                                             |      |             |         |          |     |           |         |                  |     |            |         |          |
| 1Fh-03h | <RspDBC> Buffers                                                                                                                                                                                                                                                                                                                                                      |      |             |         |          |     |           |         |                  |     |            |         |          |
| 20h     | 32 Buffers                                                                                                                                                                                                                                                                                                                                                            |      |             |         |          |     |           |         |                  |     |            |         |          |
| 3Fh-21h | Reserved                                                                                                                                                                                                                                                                                                                                                              |      |             |         |          |     |           |         |                  |     |            |         |          |
| 15:13   | Reserved.                                                                                                                                                                                                                                                                                                                                                             |      |             |         |          |     |           |         |                  |     |            |         |          |
| 12:8    | <b>ProbeCBC: probe command buffer count.</b> Read-write.<br>BIOS: 11h.                                                                                                                                                                                                                                                                                                |      |             |         |          |     |           |         |                  |     |            |         |          |
| 7:6     | Reserved.                                                                                                                                                                                                                                                                                                                                                             |      |             |         |          |     |           |         |                  |     |            |         |          |
| 5:0     | <b>RspCBC: response command buffer count.</b> Read-write.<br>BIOS: 1Fh.                                                                                                                                                                                                                                                                                               |      |             |         |          |     |           |         |                  |     |            |         |          |

### D18F3x7C Free List Buffer Count

Cold Reset: 0003\_660Ch. Out of cold reset, the processor allocates a minimal number of buffers that is smaller than the default values in the register. BIOS must use [D18F0x6C\[RlsLnkFullTokCntImm\]](#) for the values in the register to take effect. This is necessary even if the values are unchanged from the default values. See [D18F3x6C](#) and [D18F3x70](#).

- To ensure deadlock free operation the following minimum buffer allocations are required:
  - IF ([D18F3x7C\[Sri2XbarFreeRspCBC\]](#)==0) THEN ([D18F3x7C\[Sri2XbarFreeXreqCBC\]](#)>2).
  - IF ([D18F3x7C\[Sri2XbarFreeRspCBC\]](#)!=0) THEN ([D18F3x7C\[Sri2XbarFreeRspCBC\]](#)>2).
  - IF ([D18F3x7C\[Sri2XbarFreeRspDBC\]](#)==0) THEN ([D18F3x7C\[Sri2XbarFreeXreqDBC\]](#)>2).
  - IF ([D18F3x7C\[Sri2XbarFreeRspDBC\]](#)!=0) THEN ([D18F3x7C\[Sri2XbarFreeRspDBC\]](#)>2).
  - [D18F3x7C\[Xbar2SriFreeListCBC\]](#) >= ([D18F3x1A0\[CpuToNbFreeBufCnt\]](#) \* [NumOfCompUnits](#)) + 2.

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                      |
|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31    | Reserved.                                                                                                                                                                                                                                                                                                                                                                        |
| 30:28 | <b>Xbar2SriFreeListCBInc: XBAR to SRI free list command buffer increment.</b> Read-write. This field is use to add buffers to the free list pool if they are reclaimed from hard allocated entries without having to go through warm reset. This field may only be programmed after buffers have been allocated and released via <a href="#">D18F0x6C[RlsLnkFullTokCntImm]</a> . |
| 27:23 | Reserved.                                                                                                                                                                                                                                                                                                                                                                        |
| 22:20 | <b>Sri2XbarFreeRspDBC: SRI to XBAR free response data buffer count.</b> Read-write. BIOS: 0.                                                                                                                                                                                                                                                                                     |
| 19:16 | <b>Sri2XbarFreeXreqDBC: SRI to XBAR free request and posted request data buffer count.</b> Read-write.<br>BIOS: 5h.<br>If <a href="#">Sri2XbarFreeRspDBC</a> =0h, then these buffers are shared between requests, responses and posted requests and the number of buffers allocated is two times the value of this field.                                                        |
| 15:12 | <b>Sri2XbarFreeRspCBC: SRI to XBAR free response command buffer count.</b> Read-write. BIOS: 0h.                                                                                                                                                                                                                                                                                 |
| 11:8  | <b>Sri2XbarFreeXreqCBC: SRI to XBAR free request and posted request command buffer count.</b> Read-write.<br>BIOS: Eh.<br>If <a href="#">Sri2XbarFreeRspCBC</a> =0h, then these buffers are shared between requests, responses and posted requests and the number of buffers allocated is two times the value of this field.                                                     |
| 7:6   | Reserved.                                                                                                                                                                                                                                                                                                                                                                        |
| 5:0   | <b>Xbar2SriFreeListCBC: XBAR to SRI free list command buffer count.</b> Read-write.<br>BIOS: 2Ah.                                                                                                                                                                                                                                                                                |

### D18F3x[84:80] ACPI Power State Control

This block consists of eight identical 8-bit registers, one for each System Management Action Field (SMAF) code associated with STPCLK assertion commands from the link. Refer to the descriptions below for the associated ACPI state and system management actions for each of the 8 SMAF codes. The SmafAct fields specify the system management actions taken when the corresponding SMAF code is received. For instance, a SMAF code of 5 results in the power management actions specified by SmafAct5. Some ACPI states and associated SMAF codes may not be supported in certain conditions. See [2.5 \[Power Management\]](#) for which states are supported.

When a link STPCLK assertion command is received by the processor, the power management commands specified by the register with the corresponding SMAF code are invoked. When the STPCLK deassertion command is received by the processor, the processor returns into the operational state.

In multi-node systems, these registers should be programmed identically in all nodes.

**Table 185: SMAF Action Definition**

| Register                         | SmafAct  | ACPI state         | Description                                                                                                                                                                                         |
|----------------------------------|----------|--------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <a href="#">D18F3x84</a> [31:24] | SmafAct7 | C1                 | Initiated when a Halt instruction is executed by processor. This does not involve the interaction with the SMC, therefore the SMC is required to never send STPCLK assertion commands with SMAF=7h. |
| <a href="#">D18F3x84</a> [23:16] | SmafAct6 | S4/S5              | Initiated by a processor access to the ACPI-defined PM1_CNTa register.                                                                                                                              |
| <a href="#">D18F3x84</a> [15:8]  | SmafAct5 | Throttling         | Occurs based upon SMC hardware-initiated throttling. AMD recommends using PROCHOT_L for thermal throttling and not implementing stop clock based throttling.                                        |
| <a href="#">D18F3x84</a> [7:0]   | SmafAct4 | S3                 | Initiated by a processor access to the ACPI-defined PM1_CNTa register.                                                                                                                              |
| <a href="#">D18F3x80</a> [31:24] | SmafAct3 | S1                 | Initiated by a processor access to the ACPI-defined PM1_CNTa register.                                                                                                                              |
| <a href="#">D18F3x80</a> [23:16] | SmafAct2 | -                  |                                                                                                                                                                                                     |
| <a href="#">D18F3x80</a> [15:8]  | SmafAct1 | C1E, or Link init. | Initiated by an access to the ACPI-defined P_LVL3 register.                                                                                                                                         |
| <a href="#">D18F3x80</a> [7:0]   | SmafAct0 | C2                 | Initiated by a processor access to the ACPI-defined P_LVL2 register.                                                                                                                                |

#### **D18F3x80 ACPI Power State Control Low**

Reset: 0000\_0000h. Read-write.

| Bits  | Description                                         |
|-------|-----------------------------------------------------|
| 31:29 | <b>ClkDivisorSmafAct3.</b> See: ClkDivisorSmafAct0. |
| 28:27 | Reserved.                                           |
| 26    | <b>NbGateEnSmafAct3.</b> See: NbGateEnSmafAct0.     |
| 25    | <b>NbLowPwrEnSmafAct3.</b> See: NbLowPwrEnSmafAct0. |
| 24    | <b>CpuPrbEnSmafAct3.</b> See: CpuPrbEnSmafAct0.     |
| 23:21 | <b>ClkDivisorSmafAct2.</b> See: ClkDivisorSmafAct0. |
| 20:19 | Reserved.                                           |
| 18    | <b>NbGateEnSmafAct2.</b> See: NbGateEnSmafAct0.     |
| 17    | <b>NbLowPwrEnSmafAct2.</b> See: NbLowPwrEnSmafAct0. |
| 16    | <b>CpuPrbEnSmafAct2.</b> See: CpuPrbEnSmafAct0.     |
| 15:13 | <b>ClkDivisorSmafAct1.</b> See: ClkDivisorSmafAct0. |

|             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |             |                    |             |                    |      |    |      |     |      |    |      |      |      |    |      |      |      |    |      |                 |
|-------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|--------------------|-------------|--------------------|------|----|------|-----|------|----|------|------|------|----|------|------|------|----|------|-----------------|
| 12:11       | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |             |                    |             |                    |      |    |      |     |      |    |      |      |      |    |      |      |      |    |      |                 |
| 10          | <b>NbGateEnSmafAct1.</b> See: NbGateEnSmafAct0.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |             |                    |             |                    |      |    |      |     |      |    |      |      |      |    |      |      |      |    |      |                 |
| 9           | <b>NbLowPwrEnSmafAct1.</b> See: NbLowPwrEnSmafAct0.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |             |                    |             |                    |      |    |      |     |      |    |      |      |      |    |      |      |      |    |      |                 |
| 8           | <b>CpuPrbEnSmafAct1.</b> See: CpuPrbEnSmafAct0.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |             |                    |             |                    |      |    |      |     |      |    |      |      |      |    |      |      |      |    |      |                 |
| 7:5         | <b>ClkDivisorSmafAct0: clock divisor.</b> Read-write. Specifies the core clock frequency while in the low-power state. This divisor is relative to the current FID frequency, or: <ul style="list-style-type: none"><li>100 MHz * (10h + MSRC001_00[6B:64][CpuFid[5:0]]) of the current P-state specified by MSRC001_0063[CurPstate].</li></ul> If MSRC001_00[6B:64][CpuDid] of the current P-state indicates a divisor that is deeper than specified by this field, then no frequency change is made when entering the low-power state associated with this register. <table><tr><td><u>Bits</u></td><td><u>Description</u></td><td><u>Bits</u></td><td><u>Description</u></td></tr><tr><td>000b</td><td>/1</td><td>100b</td><td>/16</td></tr><tr><td>001b</td><td>/2</td><td>101b</td><td>/128</td></tr><tr><td>010b</td><td>/4</td><td>110b</td><td>/512</td></tr><tr><td>011b</td><td>/8</td><td>111b</td><td>Turn off clocks</td></tr></table>                                                                                                                                                                                                                                                                                                                               | <u>Bits</u> | <u>Description</u> | <u>Bits</u> | <u>Description</u> | 000b | /1 | 100b | /16 | 001b | /2 | 101b | /128 | 010b | /4 | 110b | /512 | 011b | /8 | 111b | Turn off clocks |
| <u>Bits</u> | <u>Description</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <u>Bits</u> | <u>Description</u> |             |                    |      |    |      |     |      |    |      |      |      |    |      |      |      |    |      |                 |
| 000b        | /1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 100b        | /16                |             |                    |      |    |      |     |      |    |      |      |      |    |      |      |      |    |      |                 |
| 001b        | /2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 101b        | /128               |             |                    |      |    |      |     |      |    |      |      |      |    |      |      |      |    |      |                 |
| 010b        | /4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 110b        | /512               |             |                    |      |    |      |     |      |    |      |      |      |    |      |      |      |    |      |                 |
| 011b        | /8                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 111b        | Turn off clocks    |             |                    |      |    |      |     |      |    |      |      |      |    |      |      |      |    |      |                 |
| 4:3         | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |             |                    |             |                    |      |    |      |     |      |    |      |      |      |    |      |      |      |    |      |                 |
| 2           | <b>NbGateEnSmafAct0: northbridge gate enable.</b> Read-write. This bit does not control hardware. NbLowPwrEn is required to be set if this bit is set.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |             |                    |             |                    |      |    |      |     |      |    |      |      |      |    |      |      |      |    |      |                 |
| 1           | <b>NbLowPwrEnSmafAct0: Northbridge low-power enable.</b> Read-write. 1=The NB clock is ramped down to the divisor specified by D18F3xD4[NbClkDiv] and DRAM is placed into self-refresh mode when LDTSTOP_L is asserted while in the low-power state.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |             |                    |             |                    |      |    |      |     |      |    |      |      |      |    |      |      |      |    |      |                 |
| 0           | <b>CpuPrbEnSmafAct0: CPU direct probe enable.</b> Read-write. Specifies how probes are handled while in the low-power state. 0=When the probe request comes into the NB, the core clock is brought up to the COF (based on the current P-state), all outstanding probes are completed, the core waits for a hysteresis time based on D18F3xD4[ClkRampHystSel], and then the core clock is brought down to the frequency specified by ClkDivisor. 1=The core clock does not change frequency; the probe is handled at the frequency specified by ClkDivisor; this may only be set if: <ul style="list-style-type: none"><li>ClkDivisor specifies a divide-by 1, 2, 4, 8, or 16 and NbCof &lt;= 3.2 GHz</li><li>ClkDivisor specifies a divide-by 1, 2, 4, or 8 and NbCof &gt;= 3.4 GHz</li></ul> This bit also specifies functionality of the timer used for cache flushing during halt. See D18F3xDC[CacheFlushOnHaltTmr]. <ul style="list-style-type: none"><li>If ((D18F3x84[CpuPrbEnSmafAct7]==0) &amp;&amp; (D18F3xDC[IgnCpuPrbEn]==0)), only the time when the core is halted and has its clocks ramped up to service probes is counted.</li><li>If ((D18F3x84[CpuPrbEnSmafAct7]==1) or (D18F3xDC[IgnCpuPrbEn]==1)), all of the time the core is halted is counted.</li></ul> |             |                    |             |                    |      |    |      |     |      |    |      |      |      |    |      |      |      |    |      |                 |

### D18F3x84 ACPI Power State Control High

Reset: 0000\_0000h. Read-write.

| Bits  | Description                                                   |
|-------|---------------------------------------------------------------|
| 31:29 | <b>ClkDivisorSmafAct7.</b> See: D18F3x80[ClkDivisorSmafAct0]. |
| 28:27 | Reserved.                                                     |
| 26    | <b>NbGateEnSmafAct7.</b> See: D18F3x80[NbGateEnSmafAct0].     |
| 25    | <b>NbLowPwrEnSmafAct7.</b> See: D18F3x80[NbLowPwrEnSmafAct0]. |

|       |                                                                                               |
|-------|-----------------------------------------------------------------------------------------------|
| 24    | <b>CpuPrbEnSmafAct7.</b> See: <a href="#">D18F3x80</a> [CpuPrbEnSmafAct0].                    |
| 23:21 | <b>ClkDivisorSmafAct6.</b> See: <a href="#">D18F3x80</a> [ClkDivisorSmafAct0].                |
| 20:19 | Reserved.                                                                                     |
| 18    | <b>NbGateEnSmafAct6.</b> See: <a href="#">D18F3x80</a> [NbGateEnSmafAct0].                    |
| 17    | <b>NbLowPwrEnSmafAct6.</b> See: <a href="#">D18F3x80</a> [NbLowPwrEnSmafAct0].                |
| 16    | <b>CpuPrbEnSmafAct6.</b> See: <a href="#">D18F3x80</a> [CpuPrbEnSmafAct0].                    |
| 15:13 | <b>ClkDivisorSmafAct5.</b> See: <a href="#">D18F3x80</a> [ClkDivisorSmafAct0].                |
| 12:11 | Reserved.                                                                                     |
| 10    | <b>NbGateEnSmafAct5.</b> See: <a href="#">D18F3x80</a> [NbGateEnSmafAct0].                    |
| 9     | <b>NbLowPwrEnSmafAct5.</b> See: <a href="#">D18F3x80</a> [NbLowPwrEnSmafAct0].                |
| 8     | <b>CpuPrbEnSmafAct5.</b> See: <a href="#">D18F3x80</a> [CpuPrbEnSmafAct0].                    |
| 7:5   | <b>ClkDivisorSmafAct4.</b> See: <a href="#">D18F3x80</a> [ClkDivisorSmafAct0].<br>BIOS: 111b. |
| 4:3   | Reserved.                                                                                     |
| 2     | <b>NbGateEnSmafAct4.</b> See: <a href="#">D18F3x80</a> [NbGateEnSmafAct0].                    |
| 1     | <b>NbLowPwrEnSmafAct4.</b> See: <a href="#">D18F3x80</a> [NbLowPwrEnSmafAct0]. BIOS: 1.       |
| 0     | <b>CpuPrbEnSmafAct4.</b> See: <a href="#">D18F3x80</a> [CpuPrbEnSmafAct0].                    |

#### D18F3x88 NB Configuration 1 Low (NB\_CFG1\_LO)

| Bits | Description                                                                                                      |
|------|------------------------------------------------------------------------------------------------------------------|
| 31:0 | <a href="#">MSRC001_001F</a> [31:0] is an alias of <a href="#">D18F3x88</a> . See <a href="#">MSRC001_001F</a> . |

#### D18F3x8C NB Configuration 1 High (NB\_CFG1\_HI)

| Bits | Description                                                                                                       |
|------|-------------------------------------------------------------------------------------------------------------------|
| 31:0 | <a href="#">MSRC001_001F</a> [63:32] is an alias of <a href="#">D18F3x8C</a> . See <a href="#">MSRC001_001F</a> . |

#### D18F3xA0 Power Control Miscellaneous

| Bits | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31   | <b>CofVidProg: COF and VID of P-states programmed.</b> Read-only. Reset: Product-specific. 1=Out of cold reset, the VID, FID, and DID values of the P-state registers specified by <a href="#">MSRC001_0071</a> [StartupPstate] and <a href="#">D18F5x174</a> [StartupNbPstate] have been applied to the processor. 0=Out of cold reset, the boot VID is applied to all processor power planes, the NB clock plane is set to 800 MHz (with a FID of 00h=800 MHz and a DID of 0b) and core CPU clock planes are set to 800 MHz (with a FID of 00h=1.6 GHz and a DID of 1h). Registers containing P-state information such as FID, DID, and VID values are valid out of cold reset independent of the state of <a href="#">D18F3xA0</a> [CofVidProg]. BIOS must transition the processor to a valid P-state out of cold reset when <a href="#">D18F3xA0</a> [CofVidProg]=0. See 2.5.3.1.6 [BIOS Requirements for Core P-state Initialization and Transitions]. |



|             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |             |                    |             |                    |      |      |      |      |      |      |      |       |      |      |      |          |      |      |      |          |
|-------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|--------------------|-------------|--------------------|------|------|------|------|------|------|------|-------|------|------|------|----------|------|------|------|----------|
| 30:28       | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |             |                    |             |                    |      |      |      |      |      |      |      |       |      |      |      |          |      |      |      |          |
| 27:16       | <b>ConfigId: Configuration identifier.</b> Read-only. Reset: Product-specific. Specifies the configuration ID associated with the product.                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |             |                    |             |                    |      |      |      |      |      |      |      |       |      |      |      |          |      |      |      |          |
| 15          | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |             |                    |             |                    |      |      |      |      |      |      |      |       |      |      |      |          |      |      |      |          |
| 14          | <b>Svi2HighFreqSel: SVI2 high frequency select.</b> Read-write. Cold reset: 0. BIOS: 1. 0=3.4 MHz. 1=20 MHz. Writes to this field take effect at the next SVI command boundary. If 20 MHz is supported by the VRM, BIOS should program this to 1 prior to any VID transitions. Once this bit is set, it should not be cleared until the next cold reset.                                                                                                                                                                                                                                                                |             |                    |             |                    |      |      |      |      |      |      |      |       |      |      |      |          |      |      |      |          |
| 13:11       | <b>PllLockTime: PLL synchronization lock time.</b> Read-write. Reset: 0. BIOS: 001b. If a P-state change occurs that applies a new FID to the PLL, this field specifies the time required for the PLL to lock to the new frequency. <table><tr><td><u>Bits</u></td><td><u>Description</u></td><td><u>Bits</u></td><td><u>Description</u></td></tr><tr><td>000b</td><td>1 us</td><td>100b</td><td>8 us</td></tr><tr><td>001b</td><td>2 us</td><td>101b</td><td>16 us</td></tr><tr><td>010b</td><td>3 us</td><td>110b</td><td>Reserved</td></tr><tr><td>011b</td><td>4 us</td><td>111b</td><td>Reserved</td></tr></table> | <u>Bits</u> | <u>Description</u> | <u>Bits</u> | <u>Description</u> | 000b | 1 us | 100b | 8 us | 001b | 2 us | 101b | 16 us | 010b | 3 us | 110b | Reserved | 011b | 4 us | 111b | Reserved |
| <u>Bits</u> | <u>Description</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <u>Bits</u> | <u>Description</u> |             |                    |      |      |      |      |      |      |      |       |      |      |      |          |      |      |      |          |
| 000b        | 1 us                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 100b        | 8 us               |             |                    |      |      |      |      |      |      |      |       |      |      |      |          |      |      |      |          |
| 001b        | 2 us                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 101b        | 16 us              |             |                    |      |      |      |      |      |      |      |       |      |      |      |          |      |      |      |          |
| 010b        | 3 us                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 110b        | Reserved           |             |                    |      |      |      |      |      |      |      |       |      |      |      |          |      |      |      |          |
| 011b        | 4 us                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 111b        | Reserved           |             |                    |      |      |      |      |      |      |      |       |      |      |      |          |      |      |      |          |
| 10          | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |             |                    |             |                    |      |      |      |      |      |      |      |       |      |      |      |          |      |      |      |          |
| 9           | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |             |                    |             |                    |      |      |      |      |      |      |      |       |      |      |      |          |      |      |      |          |
| 8           | <b>PsiVid[7].</b> Read-write. Reset: 0. BIOS: 2.5.1.3.1.1. See PsiVid[6:0].                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |             |                    |             |                    |      |      |      |      |      |      |      |       |      |      |      |          |      |      |      |          |
| 7           | <b>PsiVidEn: PSI_L VID enable.</b> Read-write. Reset: 0. BIOS: 2.5.1.3.1.1. This bit specifies how PSI_L is controlled. This signal may be used by the voltage regulator to improve efficiency while in reduced power states. 1=Control over the PSI_L signal is as specified by the PsiVid field of this register. 0=PSI_L is always high. See 2.5.1.3.1 [PSIx_L Bit].                                                                                                                                                                                                                                                 |             |                    |             |                    |      |      |      |      |      |      |      |       |      |      |      |          |      |      |      |          |
| 6:0         | <b>PsiVid[6:0]: PSI_L VID threshold.</b> Read-write. Reset: 0. BIOS: 2.5.1.3.1.1. PsiVid[7:0] = {PsiVid[7], PsiVid[6:0]}. When enabled by PsiVidEn, PsiVid[7:0] specifies the threshold value of the VID code generated by the processor, which in turn determines the state of PSI0_L. When the VID code generated by the processor is less than PsiVid[7:0] (i.e., the VID code is specifying a higher voltage level than the PsiVid-specified voltage level), then PSI0_L is high; when the VID code is greater than or equal to PsiVid[7:0], PSI0_L is driven low. See 2.5.1.3.1 [PSIx_L Bit].                      |             |                    |             |                    |      |      |      |      |      |      |      |       |      |      |      |          |      |      |      |          |

### D18F3xA4 Reported Temperature Control

The slew rate controls in this register are used to filter processor temperature measurements. Separate controls are provided for a measured temperature that is higher or lower than Tctl. The per-step timer counts as long as the measured temperature stays either above or below Tctl. Each time the measured temperature changes to the other side of Tctl, the step timer resets, and Tctl is not changed. If, for example, step times are enabled in both directions, Tctl=62.625, and the measured temperature keeps jumping quickly between 62.5 and 63.0, then (assuming the step times are long enough) Tctl would not change. However, once the measured temperature settles on one side of Tctl, Tctl can step toward the measured temperature. If the difference of measured temperature minus Tctl is greater than the value set by MaxTmpDiffUp, then Tctl is set equal to the measured temperature. See 2.10 [Thermal Functions].



| Bits      | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                     |                 |             |                                                                                      |     |           |      |           |         |                                                                                                               |   |                     |      |   |         |      |   |   |      |   |       |           |   |                |      |   |         |
|-----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|-----------------|-------------|--------------------------------------------------------------------------------------|-----|-----------|------|-----------|---------|---------------------------------------------------------------------------------------------------------------|---|---------------------|------|---|---------|------|---|---|------|---|-------|-----------|---|----------------|------|---|---------|
| 31:21     | <b>CurTmp: current temperature.</b><br>IF (D18F3xA4[CurTmpTjSel]==11b) THEN Read-write. ELSE Read-only, updated-by-hardware. ENDIF. Reset: X. Provides the current control temperature, Tctl, after the slew-rate controls have been applied.<br>RangeUnadjusted = (D18F3xA4[CurTmpTjSel]!=11b). <table><tr><th>Bits</th><th>RangeUnadjusted</th><th>Description</th></tr><tr><td>000h</td><td>0</td><td>-49</td></tr><tr><td>001h</td><td>0</td><td>-48.875</td></tr><tr><td>7FEh-002h</td><td>0</td><td>&lt;(CurTmp*0.125)-49&gt;</td></tr><tr><td>7FFh</td><td>0</td><td>206.875</td></tr><tr><td>000h</td><td>1</td><td>0</td></tr><tr><td>001h</td><td>1</td><td>0.125</td></tr><tr><td>7FEh-002h</td><td>1</td><td>&lt;CurTmp*0.125&gt;</td></tr><tr><td>7FFh</td><td>1</td><td>255.875</td></tr></table> | Bits                | RangeUnadjusted | Description | 000h                                                                                 | 0   | -49       | 001h | 0         | -48.875 | 7FEh-002h                                                                                                     | 0 | <(CurTmp*0.125)-49> | 7FFh | 0 | 206.875 | 000h | 1 | 0 | 001h | 1 | 0.125 | 7FEh-002h | 1 | <CurTmp*0.125> | 7FFh | 1 | 255.875 |
| Bits      | RangeUnadjusted                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Description         |                 |             |                                                                                      |     |           |      |           |         |                                                                                                               |   |                     |      |   |         |      |   |   |      |   |       |           |   |                |      |   |         |
| 000h      | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | -49                 |                 |             |                                                                                      |     |           |      |           |         |                                                                                                               |   |                     |      |   |         |      |   |   |      |   |       |           |   |                |      |   |         |
| 001h      | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | -48.875             |                 |             |                                                                                      |     |           |      |           |         |                                                                                                               |   |                     |      |   |         |      |   |   |      |   |       |           |   |                |      |   |         |
| 7FEh-002h | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <(CurTmp*0.125)-49> |                 |             |                                                                                      |     |           |      |           |         |                                                                                                               |   |                     |      |   |         |      |   |   |      |   |       |           |   |                |      |   |         |
| 7FFh      | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 206.875             |                 |             |                                                                                      |     |           |      |           |         |                                                                                                               |   |                     |      |   |         |      |   |   |      |   |       |           |   |                |      |   |         |
| 000h      | 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 0                   |                 |             |                                                                                      |     |           |      |           |         |                                                                                                               |   |                     |      |   |         |      |   |   |      |   |       |           |   |                |      |   |         |
| 001h      | 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 0.125               |                 |             |                                                                                      |     |           |      |           |         |                                                                                                               |   |                     |      |   |         |      |   |   |      |   |       |           |   |                |      |   |         |
| 7FEh-002h | 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <CurTmp*0.125>      |                 |             |                                                                                      |     |           |      |           |         |                                                                                                               |   |                     |      |   |         |      |   |   |      |   |       |           |   |                |      |   |         |
| 7FFh      | 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 255.875             |                 |             |                                                                                      |     |           |      |           |         |                                                                                                               |   |                     |      |   |         |      |   |   |      |   |       |           |   |                |      |   |         |
| 20        | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                     |                 |             |                                                                                      |     |           |      |           |         |                                                                                                               |   |                     |      |   |         |      |   |   |      |   |       |           |   |                |      |   |         |
| 19:18     | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                     |                 |             |                                                                                      |     |           |      |           |         |                                                                                                               |   |                     |      |   |         |      |   |   |      |   |       |           |   |                |      |   |         |
| 17:16     | <b>CurTmpTjSel: Current temperature select.</b> Read-write. Reset: 00. These bits may be used for diagnostic software. <table><tr><th>Bits</th><th>Description</th></tr><tr><td>00b</td><td>CurTmp provides the read-only Tctl value.</td></tr><tr><td>01b</td><td>Reserved.</td></tr><tr><td>10b</td><td>Reserved.</td></tr><tr><td>11b</td><td>CurTmp is a read-write register that specifies a value used to create Tctl. The two LSB's are read-only zero.</td></tr></table>                                                                                                                                                                                                                                                                                                                                | Bits                | Description     | 00b         | CurTmp provides the read-only Tctl value.                                            | 01b | Reserved. | 10b  | Reserved. | 11b     | CurTmp is a read-write register that specifies a value used to create Tctl. The two LSB's are read-only zero. |   |                     |      |   |         |      |   |   |      |   |       |           |   |                |      |   |         |
| Bits      | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                     |                 |             |                                                                                      |     |           |      |           |         |                                                                                                               |   |                     |      |   |         |      |   |   |      |   |       |           |   |                |      |   |         |
| 00b       | CurTmp provides the read-only Tctl value.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                     |                 |             |                                                                                      |     |           |      |           |         |                                                                                                               |   |                     |      |   |         |      |   |   |      |   |       |           |   |                |      |   |         |
| 01b       | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                     |                 |             |                                                                                      |     |           |      |           |         |                                                                                                               |   |                     |      |   |         |      |   |   |      |   |       |           |   |                |      |   |         |
| 10b       | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                     |                 |             |                                                                                      |     |           |      |           |         |                                                                                                               |   |                     |      |   |         |      |   |   |      |   |       |           |   |                |      |   |         |
| 11b       | CurTmp is a read-write register that specifies a value used to create Tctl. The two LSB's are read-only zero.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                     |                 |             |                                                                                      |     |           |      |           |         |                                                                                                               |   |                     |      |   |         |      |   |   |      |   |       |           |   |                |      |   |         |
| 15:13     | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                     |                 |             |                                                                                      |     |           |      |           |         |                                                                                                               |   |                     |      |   |         |      |   |   |      |   |       |           |   |                |      |   |         |
| 12:8      | <b>PerStepTimeDn: per step time down.</b> Read-write. Cold reset: 18h. BIOS: 0Fh. Specifies the time that measured temperature must remain below Tctl before applying a 0.125 downward step. See: PerStepTimeUp.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                     |                 |             |                                                                                      |     |           |      |           |         |                                                                                                               |   |                     |      |   |         |      |   |   |      |   |       |           |   |                |      |   |         |
| 7         | <b>TmpSlewDnEn: temperature slew downward enable.</b> Read-write. Cold reset: 0. BIOS: 1. 1=Downward slewing enabled. 0=Downward slewing disabled.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                     |                 |             |                                                                                      |     |           |      |           |         |                                                                                                               |   |                     |      |   |         |      |   |   |      |   |       |           |   |                |      |   |         |
| 6:5       | <b>TmpMaxDiffUp: temperature maximum difference up.</b> Read-write. Cold reset: 00b. BIOS: 11b. Specifies the maximum difference, (measured temperature - Tctl), when Tctl immediatly updates to the measured temperature. <table><tr><th>Bits</th><th>Description</th></tr><tr><td>00b</td><td>0.0 (disable upward slew)</td></tr><tr><td>01b</td><td>1.0</td></tr><tr><td>10b</td><td>3.0</td></tr><tr><td>11b</td><td>9.0</td></tr></table>                                                                                                                                                                                                                                                                                                                                                                  | Bits                | Description     | 00b         | 0.0 (disable upward slew)                                                            | 01b | 1.0       | 10b  | 3.0       | 11b     | 9.0                                                                                                           |   |                     |      |   |         |      |   |   |      |   |       |           |   |                |      |   |         |
| Bits      | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                     |                 |             |                                                                                      |     |           |      |           |         |                                                                                                               |   |                     |      |   |         |      |   |   |      |   |       |           |   |                |      |   |         |
| 00b       | 0.0 (disable upward slew)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                     |                 |             |                                                                                      |     |           |      |           |         |                                                                                                               |   |                     |      |   |         |      |   |   |      |   |       |           |   |                |      |   |         |
| 01b       | 1.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                     |                 |             |                                                                                      |     |           |      |           |         |                                                                                                               |   |                     |      |   |         |      |   |   |      |   |       |           |   |                |      |   |         |
| 10b       | 3.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                     |                 |             |                                                                                      |     |           |      |           |         |                                                                                                               |   |                     |      |   |         |      |   |   |      |   |       |           |   |                |      |   |         |
| 11b       | 9.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                     |                 |             |                                                                                      |     |           |      |           |         |                                                                                                               |   |                     |      |   |         |      |   |   |      |   |       |           |   |                |      |   |         |
| 4:0       | <b>PerStepTimeUp: per 1/8th degree step time up.</b> Read-write. Cold reset: 00h. BIOS: 0Fh. Specifies the time that measured temperature must remain above Tctl before applying a 0.125 upward step. <table><tr><th>Bits</th><th>Definition</th></tr><tr><td>1Fh-00h</td><td>&lt;(PerStepTimeUp[2:0] + 1) * 10^PerStepTimeUp[4:3]&gt; ms, ranging from 1 ms to 8000 ms.</td></tr></table>                                                                                                                                                                                                                                                                                                                                                                                                                      | Bits                | Definition      | 1Fh-00h     | <(PerStepTimeUp[2:0] + 1) * 10^PerStepTimeUp[4:3]> ms, ranging from 1 ms to 8000 ms. |     |           |      |           |         |                                                                                                               |   |                     |      |   |         |      |   |   |      |   |       |           |   |                |      |   |         |
| Bits      | Definition                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                     |                 |             |                                                                                      |     |           |      |           |         |                                                                                                               |   |                     |      |   |         |      |   |   |      |   |       |           |   |                |      |   |         |
| 1Fh-00h   | <(PerStepTimeUp[2:0] + 1) * 10^PerStepTimeUp[4:3]> ms, ranging from 1 ms to 8000 ms.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                     |                 |             |                                                                                      |     |           |      |           |         |                                                                                                               |   |                     |      |   |         |      |   |   |      |   |       |           |   |                |      |   |         |

### D18F3xA8 Pop Up and Down P-states

| Bits  | Description                                                                                                                                                                                                                                                                      |
|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:29 | <b>PopDownPstate</b> . Read-write. Reset: <a href="#">D18F3xDC[HwPstateMaxVal]</a> . BIOS: <a href="#">D18F3xDC[HwPstateMaxVal]</a> . Specifies the pop-down P-state number. This field uses hardware P-state numbering. See <a href="#">2.5.3.2.3.3 [Core C6 (CC6) State]</a> . |
| 28:0  | Reserved.                                                                                                                                                                                                                                                                        |

### D18F3xB8 NB Array Address

Reset: xxxx\_xxxxh. [D18F3xB8 \[NB Array Address\]](#) and [D18F3xBC \[NB Array Data Port\]](#) provide a mechanism to inject errors into DRAM and data read from internal NB arrays.

[D18F3xB8](#) should first be written with the target array and address within the array. Read and write accesses to [D18F3xBC](#) then access the target address within the target array.

| Bits        | Description                                                                                                                                                                                                                                                                                                       |             |             |       |           |            |                                        |       |          |
|-------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|-------------|-------|-----------|------------|----------------------------------------|-------|----------|
| 31:28       | <b>ArraySelect</b> . Read-write. Selects the NB array to access.<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>7h-0h</td><td>Reserved</td></tr> <tr> <td>8h</td><td><a href="#">D18F3xBC_x8 [DRAM ECC]</a></td></tr> <tr> <td>Fh-9h</td><td>Reserved</td></tr> </table>                         | Bits        | Description | 7h-0h | Reserved  | 8h         | <a href="#">D18F3xBC_x8 [DRAM ECC]</a> | Fh-9h | Reserved |
| Bits        | Description                                                                                                                                                                                                                                                                                                       |             |             |       |           |            |                                        |       |          |
| 7h-0h       | Reserved                                                                                                                                                                                                                                                                                                          |             |             |       |           |            |                                        |       |          |
| 8h          | <a href="#">D18F3xBC_x8 [DRAM ECC]</a>                                                                                                                                                                                                                                                                            |             |             |       |           |            |                                        |       |          |
| Fh-9h       | Reserved                                                                                                                                                                                                                                                                                                          |             |             |       |           |            |                                        |       |          |
| 27:10       | Reserved.                                                                                                                                                                                                                                                                                                         |             |             |       |           |            |                                        |       |          |
| 9:0         | <b>ArrayAddress</b> . Read-write. Selects the location to access within the selected array. This format of this field is a function of ArraySelect.<br><table> <tr> <th>ArraySelect</th><th>Description</th></tr> <tr> <td>8h</td><td>DRAM ECC.</td></tr> <tr> <td>All others</td><td>Reserved</td></tr> </table> | ArraySelect | Description | 8h    | DRAM ECC. | All others | Reserved                               |       |          |
| ArraySelect | Description                                                                                                                                                                                                                                                                                                       |             |             |       |           |            |                                        |       |          |
| 8h          | DRAM ECC.                                                                                                                                                                                                                                                                                                         |             |             |       |           |            |                                        |       |          |
| All others  | Reserved                                                                                                                                                                                                                                                                                                          |             |             |       |           |            |                                        |       |          |

### D18F3xBC NB Array Data Port

See [D18F3xB8](#) for register access information. Address: [D18F3xB8\[ArraySelect\]](#).

| Bits | Description   |
|------|---------------|
| 31:0 | <b>Data</b> . |

### D18F3xBC\_x8 DRAM ECC

This register controls injection of errors in writes to DRAM. See [2.15.3.1 \[DRAM Error Injection\]](#).

| Bits  | Description |
|-------|-------------|
| 31:29 | Reserved.   |

| 28:20 | <p><b>ErrInjEn: enable error injection to word.</b> Read-write. Reset: 0. Each bit in this field corresponds to a 16-bit DRAM word and enables injecting errors in that word.</p> <table> <tr> <th>Bit</th><th>Description</th></tr> <tr> <td>[0]</td><td>Data[15:0]</td></tr> <tr> <td>[1]</td><td>Data[31:16]</td></tr> <tr> <td>[2]</td><td>Data[47:32]</td></tr> <tr> <td>[3]</td><td>Data[63:48]</td></tr> <tr> <td>[4]</td><td>Data[79:64]</td></tr> <tr> <td>[5]</td><td>Data[95:80]</td></tr> <tr> <td>[6]</td><td>Data[111:96]</td></tr> <tr> <td>[7]</td><td>Data[127:112]</td></tr> <tr> <td>[8]</td><td>ECC[15:0]</td></tr> </table> | Bit | Description | [0] | Data[15:0] | [1] | Data[31:16] | [2] | Data[47:32] | [3] | Data[63:48] | [4] | Data[79:64] | [5] | Data[95:80] | [6] | Data[111:96] | [7] | Data[127:112] | [8] | ECC[15:0] |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-------------|-----|------------|-----|-------------|-----|-------------|-----|-------------|-----|-------------|-----|-------------|-----|--------------|-----|---------------|-----|-----------|
| Bit   | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |     |             |     |            |     |             |     |             |     |             |     |             |     |             |     |              |     |               |     |           |
| [0]   | Data[15:0]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |     |             |     |            |     |             |     |             |     |             |     |             |     |             |     |              |     |               |     |           |
| [1]   | Data[31:16]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |     |             |     |            |     |             |     |             |     |             |     |             |     |             |     |              |     |               |     |           |
| [2]   | Data[47:32]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |     |             |     |            |     |             |     |             |     |             |     |             |     |             |     |              |     |               |     |           |
| [3]   | Data[63:48]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |     |             |     |            |     |             |     |             |     |             |     |             |     |             |     |              |     |               |     |           |
| [4]   | Data[79:64]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |     |             |     |            |     |             |     |             |     |             |     |             |     |             |     |              |     |               |     |           |
| [5]   | Data[95:80]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |     |             |     |            |     |             |     |             |     |             |     |             |     |             |     |              |     |               |     |           |
| [6]   | Data[111:96]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |     |             |     |            |     |             |     |             |     |             |     |             |     |             |     |              |     |               |     |           |
| [7]   | Data[127:112]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |     |             |     |            |     |             |     |             |     |             |     |             |     |             |     |              |     |               |     |           |
| [8]   | ECC[15:0]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |     |             |     |            |     |             |     |             |     |             |     |             |     |             |     |              |     |               |     |           |
| 19    | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |     |             |     |            |     |             |     |             |     |             |     |             |     |             |     |              |     |               |     |           |
| 18    | <b>DramErrEn.</b> Read-write. Reset: 0. 1=Errors are continually injected on DRAM writes. The error injection takes place only on DRAM write accesses and should be initiated by a non-cacheable store. Errors continue to be injected on writes until this bit is cleared to a 0 by software.                                                                                                                                                                                                                                                                                                                                                   |     |             |     |            |     |             |     |             |     |             |     |             |     |             |     |              |     |               |     |           |
| 17    | <b>EccWrReq.</b> Read; write-1-only; cleared-by-hardware. Reset: 0. 1=Error is injected on DRAM write at the bits enabled by ErrInjEn and EccVector. A single error injection takes place on the next DRAM write access and should be initiated by a non-cacheable store. This bit is cleared by hardware after the write.                                                                                                                                                                                                                                                                                                                       |     |             |     |            |     |             |     |             |     |             |     |             |     |             |     |              |     |               |     |           |
| 16    | <b>EccRdReq.</b> Read; write-1-only; cleared-by-hardware. Reset: 0. 1=Indicates a DRAM ECC read is requested. The read takes place on the next DRAM read access and should be initiated by a non-cacheable load. The ECC bits read from DRAM are stored in EccVector. This bit is cleared by hardware after the read.                                                                                                                                                                                                                                                                                                                            |     |             |     |            |     |             |     |             |     |             |     |             |     |             |     |              |     |               |     |           |
| 15:0  | <b>EccVector: error injection vector.</b> Read-write. Reset: x. When used in conjunction with EccWrReq, each bit of EccVector enables injecting errors to the corresponding bit within each word enabled by ErrInjEn. When used in conjunction with EccRdReq, EccVector holds the contents of the DRAM ECC bits after the read.                                                                                                                                                                                                                                                                                                                  |     |             |     |            |     |             |     |             |     |             |     |             |     |             |     |              |     |               |     |           |

#### D18F3xD4 Clock Power/Timing Control 0

| Bits | Description                                                                |
|------|----------------------------------------------------------------------------|
| 31   | <b>NbClkDivApplyAll.</b> Read-write. Cold reset: 0. BIOS: 1. See NbClkDiv. |

|             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |             |                    |             |                    |       |             |       |              |       |             |       |           |       |             |       |           |       |             |       |           |       |       |       |           |       |       |       |           |       |       |       |           |       |       |       |           |
|-------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|--------------------|-------------|--------------------|-------|-------------|-------|--------------|-------|-------------|-------|-----------|-------|-------------|-------|-----------|-------|-------------|-------|-----------|-------|-------|-------|-----------|-------|-------|-------|-----------|-------|-------|-------|-----------|-------|-------|-------|-----------|
| 30:28       | <p><b>NbClkDiv: NB clock divisor.</b> Read-write. Cold reset: Product-specific. BIOS: 100b.</p> <p>Specifies the NB CLK divisor associated with <a href="#">D18F3x80/D18F3x84</a>[NbLowPwrEn]. This divisor is applied while LDTSTOP_L is asserted if the corresponding core CLK divisor, <a href="#">D18F3x80/D18F3x84</a>[ClkDivisor], is set to “turn off clocks” or if NBClkDivApplyAll=1; otherwise, the divisor specified by <a href="#">D18F3x80/D18F3x84</a>[ClkDivisor] is applied. This divisor is relative to the current NB FID frequency, or:</p> <p>100 MHz * (4 + <a href="#">D18F5x16</a>[C:0][NbFid[5:0]]).</p> <p>If <a href="#">D18F5x16</a>[C:0][NbDid] of the current NB P-state indicates a divisor that is lower than specified by this field, then no NB frequency change is made when entering the low-power state associated with this register (i.e., if this field specifies a divide-by 1 and the DID is divide-by 2, then the divisor remains 2 while in the low-power state). This field is encoded as follows:</p> <table><tr><td><u>Bits</u></td><td><u>Description</u></td><td><u>Bits</u></td><td><u>Description</u></td></tr><tr><td>000b</td><td>Divide-by 1</td><td>100b</td><td>Divide-by 16</td></tr><tr><td>001b</td><td>Divide-by 2</td><td>101b</td><td>Reserved</td></tr><tr><td>010b</td><td>Divide-by 4</td><td>110b</td><td>Reserved</td></tr><tr><td>011b</td><td>Divide-by 8</td><td>111b</td><td>Reserved</td></tr></table>                                                                                                                                                                                                                                                                                                               | <u>Bits</u> | <u>Description</u> | <u>Bits</u> | <u>Description</u> | 000b  | Divide-by 1 | 100b  | Divide-by 16 | 001b  | Divide-by 2 | 101b  | Reserved  | 010b  | Divide-by 4 | 110b  | Reserved  | 011b  | Divide-by 8 | 111b  | Reserved  |       |       |       |           |       |       |       |           |       |       |       |           |       |       |       |           |
| <u>Bits</u> | <u>Description</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <u>Bits</u> | <u>Description</u> |             |                    |       |             |       |              |       |             |       |           |       |             |       |           |       |             |       |           |       |       |       |           |       |       |       |           |       |       |       |           |       |       |       |           |
| 000b        | Divide-by 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 100b        | Divide-by 16       |             |                    |       |             |       |              |       |             |       |           |       |             |       |           |       |             |       |           |       |       |       |           |       |       |       |           |       |       |       |           |       |       |       |           |
| 001b        | Divide-by 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 101b        | Reserved           |             |                    |       |             |       |              |       |             |       |           |       |             |       |           |       |             |       |           |       |       |       |           |       |       |       |           |       |       |       |           |       |       |       |           |
| 010b        | Divide-by 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 110b        | Reserved           |             |                    |       |             |       |              |       |             |       |           |       |             |       |           |       |             |       |           |       |       |       |           |       |       |       |           |       |       |       |           |       |       |       |           |
| 011b        | Divide-by 8                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 111b        | Reserved           |             |                    |       |             |       |              |       |             |       |           |       |             |       |           |       |             |       |           |       |       |       |           |       |       |       |           |       |       |       |           |       |       |       |           |
| 27:24       | <p><b>PowerStepUp.</b> Read-write. Cold reset: 0000b. Specifies the rate at which blocks of compute unit and NB logic are gated on while the processor transitions from a quiescent state to an active state as part of a power management state transition. There are about 15 steps in this transition for each compute unit and about 5 steps for the NB for the PowerStepDown and PowerStepUp transitions. So the total transition time for a single compute unit is about 15 times the time specified by PowerStepDown and PowerStepUp and the transition time for the NB is about 5 times the time specified by PowerStepDown and PowerStepUp. Use of longer transition times may help reduce voltage transients associated with power state transitions. The bits for PowerStepUp and PowerStepDown are encoded as follows:</p> <table><tr><td><u>Bits</u></td><td><u>Description</u></td><td><u>Bits</u></td><td><u>Description</u></td></tr><tr><td>0000b</td><td>Reserved.</td><td>1000b</td><td>50 ns</td></tr><tr><td>0001b</td><td>Reserved.</td><td>1001b</td><td>Reserved.</td></tr><tr><td>0010b</td><td>Reserved.</td><td>1010b</td><td>Reserved.</td></tr><tr><td>0011b</td><td>100 ns</td><td>1011b</td><td>Reserved.</td></tr><tr><td>0100b</td><td>90 ns</td><td>1100b</td><td>Reserved.</td></tr><tr><td>0101b</td><td>80 ns</td><td>1101b</td><td>Reserved.</td></tr><tr><td>0110b</td><td>70 ns</td><td>1110b</td><td>Reserved.</td></tr><tr><td>0111b</td><td>60 ns</td><td>1111b</td><td>Reserved.</td></tr></table> <ul style="list-style-type: none"><li>• If PowerStepDown or PowerStepUp are programmed to greater than 50 ns, then the value applied to the NB is clipped to 50 ns. The compute unit steps are not clipped.</li><li>• BIOS: 1000b.</li></ul> | <u>Bits</u> | <u>Description</u> | <u>Bits</u> | <u>Description</u> | 0000b | Reserved.   | 1000b | 50 ns        | 0001b | Reserved.   | 1001b | Reserved. | 0010b | Reserved.   | 1010b | Reserved. | 0011b | 100 ns      | 1011b | Reserved. | 0100b | 90 ns | 1100b | Reserved. | 0101b | 80 ns | 1101b | Reserved. | 0110b | 70 ns | 1110b | Reserved. | 0111b | 60 ns | 1111b | Reserved. |
| <u>Bits</u> | <u>Description</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <u>Bits</u> | <u>Description</u> |             |                    |       |             |       |              |       |             |       |           |       |             |       |           |       |             |       |           |       |       |       |           |       |       |       |           |       |       |       |           |       |       |       |           |
| 0000b       | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 1000b       | 50 ns              |             |                    |       |             |       |              |       |             |       |           |       |             |       |           |       |             |       |           |       |       |       |           |       |       |       |           |       |       |       |           |       |       |       |           |
| 0001b       | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 1001b       | Reserved.          |             |                    |       |             |       |              |       |             |       |           |       |             |       |           |       |             |       |           |       |       |       |           |       |       |       |           |       |       |       |           |       |       |       |           |
| 0010b       | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 1010b       | Reserved.          |             |                    |       |             |       |              |       |             |       |           |       |             |       |           |       |             |       |           |       |       |       |           |       |       |       |           |       |       |       |           |       |       |       |           |
| 0011b       | 100 ns                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 1011b       | Reserved.          |             |                    |       |             |       |              |       |             |       |           |       |             |       |           |       |             |       |           |       |       |       |           |       |       |       |           |       |       |       |           |       |       |       |           |
| 0100b       | 90 ns                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 1100b       | Reserved.          |             |                    |       |             |       |              |       |             |       |           |       |             |       |           |       |             |       |           |       |       |       |           |       |       |       |           |       |       |       |           |       |       |       |           |
| 0101b       | 80 ns                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 1101b       | Reserved.          |             |                    |       |             |       |              |       |             |       |           |       |             |       |           |       |             |       |           |       |       |       |           |       |       |       |           |       |       |       |           |       |       |       |           |
| 0110b       | 70 ns                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 1110b       | Reserved.          |             |                    |       |             |       |              |       |             |       |           |       |             |       |           |       |             |       |           |       |       |       |           |       |       |       |           |       |       |       |           |       |       |       |           |
| 0111b       | 60 ns                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 1111b       | Reserved.          |             |                    |       |             |       |              |       |             |       |           |       |             |       |           |       |             |       |           |       |       |       |           |       |       |       |           |       |       |       |           |       |       |       |           |
| 23:20       | <p><b>PowerStepDown.</b> Read-write. Cold reset: 0000b. BIOS: 1000b. This specifies the rate at which blocks of compute unit and NB logic are gated off while the processor transitions from an active state to a quiescent state as part of a power management state transition. Valid values are the same as those for PowerStepUp.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |             |                    |             |                    |       |             |       |              |       |             |       |           |       |             |       |           |       |             |       |           |       |       |       |           |       |       |       |           |       |       |       |           |       |       |       |           |
| 19:18       | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |             |                    |             |                    |       |             |       |              |       |             |       |           |       |             |       |           |       |             |       |           |       |       |       |           |       |       |       |           |       |       |       |           |       |       |       |           |
| 17:15       | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |             |                    |             |                    |       |             |       |              |       |             |       |           |       |             |       |           |       |             |       |           |       |       |       |           |       |       |       |           |       |       |       |           |       |       |       |           |

|      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 14   | <b>CacheFlushImmOnAllHalt: cache flush immediate on all halt.</b> Read-write. Cold reset: 0. BIOS: 0. 1=Flush the caches immediately when all cores in a package have halted. The following condition must be true in order for the caches to be flushed:<br><ul style="list-style-type: none"> <li>• <a href="#">D18F4x118/D18F4x11C</a>[CacheFlushEn]=1 for the corresponding C-state action field on all cores.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 13   | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| 12   | <b>ClkRampHystCtl: clock ramp hysteresis control.</b> Read-write. Cold reset: 0. Specifies the time base for ClkRampHystSel when ( <a href="#">D18F4x128</a> [CoreCstateMode] ? ( <a href="#">D18F3x80/D18F3x84</a> [CpuPrbEn]==0) : ( <a href="#">D18F4x118/D18F4x11C</a> [CpuPrbEn]==0)). 0=320 ns. 1=1.28 us.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| 11:8 | <b>ClkRampHystSel: clock ramp hysteresis select.</b> Read-write. Cold reset: 0h. BIOS: Fh. When the core(s) are in the stop-grant or halt state and a probe request is received, the core clock may need to be brought up to service the probe.<br><ul style="list-style-type: none"> <li>• If (<a href="#">D18F4x128</a>[CoreCstateMode] ? (<a href="#">D18F3x80/D18F3x84</a>[CpuPrbEn]==0) : (<a href="#">D18F4x118/D18F4x11C</a>[CpuPrbEn]==0)) then this field specifies how long the core clock is left up to service additional probes before being brought back down. Each time a probe request is received, the hysteresis timer is reset such that the period of time specified by this field must expire with no probe request before the core clock is brought back down. The hysteresis time is encoded as (the time base specified by <a href="#">D18F3xD4</a>[ClkRampHystCtl]) * (1 + ClkRampHystSel).</li> <li>• If (<a href="#">D18F4x128</a>[CoreCstateMode] ? (<a href="#">D18F3x80/D18F3x84</a>[CpuPrbEn]==1) : (<a href="#">D18F4x118/D18F4x11C</a>[CpuPrbEn]==1)) then this field specifies a fixed amount of time to allow for probes to be serviced after completing the transition of each core. If, for example, two cores enter stop-grant or halt at the same time, then (1) the first core would complete the transition to the low power state, (2) probe traffic would be serviced for the time specified by this field, (3) the second core would complete the transition to the low power state, and (4) probe traffic would be serviced for the time specified by this field (and afterwards, until the next power state transition). For this purpose, values range from 0h=40 ns to Fh=640 ns, encoded as 40 ns * (1 + ClkRampHystSel).</li> </ul> |
| 7:6  | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| 5:0  | <b>MaxSwPstateCpuCof: maximum software P-state core COF.</b> Read-only. Cold reset: Product-specific. Specifies the maximum CPU COF supported by the processor in a software P-state. The maximum frequency is 100 MHz * MaxSwPstateCpuCof, if MaxSwPstateCpuCof is greater than zero; if MaxSwPstateCpuCof = 00h, then there is no frequency limit. Any attempt to change a software P-state CPU COF to a frequency greater than specified by this field is ignored. See <a href="#">2.5.3.1.1.1 [Software P-state Numbering]</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |

### D18F3xD8 Clock Power/Timing Control 1

See [2.5.1.4 \[Voltage Transitions\]](#).

| Bits | Description |
|------|-------------|
| 31:7 | Reserved.   |

|     |                                                                                                                                                                                                                                                                                                     |                    |             |                    |
|-----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|-------------|--------------------|
| 6:4 | <b>VSramSlamTime.</b> Read-write. Cold reset: 000b. BIOS: 100b. Specifies the time the processor waits for voltage transitions to complete before beginning an additional voltage change or a frequency change.<br>Wait time = (VSramSlamTime / 15mV) * ABS(destination voltage - current voltage). |                    |             |                    |
|     | <u>Bits</u>                                                                                                                                                                                                                                                                                         | <u>Description</u> | <u>Bits</u> | <u>Description</u> |
|     | 000b                                                                                                                                                                                                                                                                                                | 5.00 us            | 100b        | 2.00 us            |
|     | 001b                                                                                                                                                                                                                                                                                                | 3.75 us            | 101b        | 1.50 us            |
|     | 010b                                                                                                                                                                                                                                                                                                | 3.00 us            | 110b        | 1.20 us            |
|     | 011b                                                                                                                                                                                                                                                                                                | 2.40 us            | 111b        | 1.00 us            |
| 3:0 | Reserved.                                                                                                                                                                                                                                                                                           |                    |             |                    |

### D18F3xDC Clock Power/Timing Control 2

| Bits    | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |      |             |     |         |         |                                                                                        |
|---------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|-----|---------|---------|----------------------------------------------------------------------------------------|
| 31:30   | <b>NbsynPtrAdjPstate[2:1]: NB/core synchronization FIFO pointer adjust P-state[2:1].</b> Read-write. Reset: Product-specific. See NbsynPtrAdj.                                                                                                                                                                                                                                                                                                                                                                                                 |      |             |     |         |         |                                                                                        |
| 29:27   | <b>NbsynPtrAdjLo: NB/core synchronization FIFO pointer adjust low.</b> Read-write. Cold reset: 000b.<br>BIOS: IF (D18F5x260[ClkStretchEn] && D18F5x260[ClkStretchPercent]==1) THEN 011b ELSIF (D18F5x260[ClkStretchEn] && D18F5x260[ClkStretchPercent]==2) THEN 011b ELSE 101b.<br>See NbsynPtrAdj.                                                                                                                                                                                                                                            |      |             |     |         |         |                                                                                        |
| 26      | <b>IgnCpuPrbEn: ignore CPU probe enable.</b> Read-write. Cold reset: 0.<br>BIOS: 1.<br>See D18F3x80/D18F3x84[CpuPrbEn] and D18F4x118/D18F4x11C[CpuPrbEn].                                                                                                                                                                                                                                                                                                                                                                                      |      |             |     |         |         |                                                                                        |
| 25:19   | <b>CacheFlushOnHaltTmr: cache flush on halt timer.</b> Read-write. Cold reset: 00h.<br>BIOS: 32h.<br>Specifies how long each core needs to stay in a C-state before it flushes its caches. See CacheFlushOnHaltCtl, D18F3x80/D18F3x84[CpuPrbEn], and D18F4x118/D18F4x11C[CacheFlushTmrSel].<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00h</td><td>5.12 us</td></tr> <tr> <td>7Fh-01h</td><td>(&lt;CacheFlushOnHaltTmr&gt; * 10.24us) - 5.12us &lt;= Time &lt;= &lt;CacheFlushOnHaltTmr&gt; * 10.24 us</td></tr> </table> | Bits | Description | 00h | 5.12 us | 7Fh-01h | (<CacheFlushOnHaltTmr> * 10.24us) - 5.12us <= Time <= <CacheFlushOnHaltTmr> * 10.24 us |
| Bits    | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |      |             |     |         |         |                                                                                        |
| 00h     | 5.12 us                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |      |             |     |         |         |                                                                                        |
| 7Fh-01h | (<CacheFlushOnHaltTmr> * 10.24us) - 5.12us <= Time <= <CacheFlushOnHaltTmr> * 10.24 us                                                                                                                                                                                                                                                                                                                                                                                                                                                         |      |             |     |         |         |                                                                                        |

| 18:16       | <p><b>CacheFlushOnHaltCtl: cache flush on halt control.</b> Read-write. 000b.Cold reset: 000b. BIOS: 111b.</p> <p>Enables cache flush on halt when (CacheFlushOnHaltCtl != 0). Specifies what core clock divisor is used after the caches have been flushed. See <a href="#">D18F4x118/D18F4x11C</a>[CacheFlushTmrSel].</p> <table> <tr> <th><u>Bits</u></th><th><u>Description</u></th></tr> <tr> <td>000b</td><td>Divide-by 1.</td></tr> <tr> <td>001b</td><td>Divide-by 2</td></tr> <tr> <td>010b</td><td>Divide-by 4</td></tr> <tr> <td>011b</td><td>Divide-by 8</td></tr> <tr> <td>100b</td><td>Divide-by 16</td></tr> <tr> <td>101b</td><td>Reserved</td></tr> <tr> <td>110b</td><td>Reserved</td></tr> <tr> <td>111b</td><td>Turn off clocks</td></tr> </table> <p>See <a href="#">D18F3x[84:80]</a> and <a href="#">D18F4x11[C:8]</a> for clock divisor specifications that are in effect during a C-state before the caches have been flushed. See <a href="#">2.5.3.2.3.1 [C-state Probes and Cache Flushing]</a>.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <u>Bits</u> | <u>Description</u> | 000b  | Divide-by 1.                                                                                     | 001b | Divide-by 2 | 010b | Divide-by 4 | 011b | Divide-by 8 | 100b | Divide-by 16 | 101b | Reserved | 110b | Reserved | 111b | Turn off clocks |
|-------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|--------------------|-------|--------------------------------------------------------------------------------------------------|------|-------------|------|-------------|------|-------------|------|--------------|------|----------|------|----------|------|-----------------|
| <u>Bits</u> | <u>Description</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |             |                    |       |                                                                                                  |      |             |      |             |      |             |      |              |      |          |      |          |      |                 |
| 000b        | Divide-by 1.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |             |                    |       |                                                                                                  |      |             |      |             |      |             |      |              |      |          |      |          |      |                 |
| 001b        | Divide-by 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |             |                    |       |                                                                                                  |      |             |      |             |      |             |      |              |      |          |      |          |      |                 |
| 010b        | Divide-by 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |             |                    |       |                                                                                                  |      |             |      |             |      |             |      |              |      |          |      |          |      |                 |
| 011b        | Divide-by 8                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |             |                    |       |                                                                                                  |      |             |      |             |      |             |      |              |      |          |      |          |      |                 |
| 100b        | Divide-by 16                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |             |                    |       |                                                                                                  |      |             |      |             |      |             |      |              |      |          |      |          |      |                 |
| 101b        | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |             |                    |       |                                                                                                  |      |             |      |             |      |             |      |              |      |          |      |          |      |                 |
| 110b        | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |             |                    |       |                                                                                                  |      |             |      |             |      |             |      |              |      |          |      |          |      |                 |
| 111b        | Turn off clocks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |             |                    |       |                                                                                                  |      |             |      |             |      |             |      |              |      |          |      |          |      |                 |
| 15          | <p><b>NbsynPtrAdjPstate[0]: NB/core synchronization FIFO pointer adjust P-state[0].</b> Read-write. Reset: Product-specific. See NbsynPtrAdj.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |             |                    |       |                                                                                                  |      |             |      |             |      |             |      |              |      |          |      |          |      |                 |
| 14:12       | <p><b>NbsynPtrAdj: NB/core synchronization FIFO pointer adjust.</b> Read-write. Cold reset: 000b. BIOS: IF (<a href="#">D18F5x260</a>[ClkStretchEn] &amp;&amp; <a href="#">D18F5x260</a>[ClkStretchPercent]==1) THEN 011b ELSIF (<a href="#">D18F5x260</a>[ClkStretchEn] &amp;&amp; <a href="#">D18F5x260</a>[ClkStretchPercent]==2) THEN 011b ELSE 101b. Changes to this field take effect after any of the following events:</p> <ul style="list-style-type: none"> <li>• Warm reset.</li> <li>• At least one core on all compute units perform a P-state transition.</li> <li>• An NB P-state transition.</li> </ul> <p>There is a synchronization FIFO between the NB clock domain and core clock domains. At cold reset, the read pointer and write pointer for each of these FIFOs is positioned conservatively, such that FIFO latency may be greater than is necessary.</p> <p>NbsynPtrAdj and NbsynPtrAdjLo may be used to position the read pointer and write pointer of each FIFO closer to each other such that latency is reduced. Each increment of NbsynPtrAdj and NbsynPtrAdjLo represents one clock cycle of whichever is the slower clock (longer period) between the NB clock and the core clock. NbsynPtrAdj is used when the core P-state is less than or equal to NbsynPtrAdjPstate, otherwise NbsynPtrAdjLo is used.</p> <p>Values less than the recommended value are allowed; values greater than the recommended value are illegal.</p> <table> <tr> <th><u>Bits</u></th><th><u>Description</u></th></tr> <tr> <td>6h-0h</td><td>Position the read pointer &lt;NbsynPtrAdj, NbsynPtrAdjLo&gt; clock cycles closer to the write pointer.</td></tr> <tr> <td>7h</td><td>Reserved</td></tr> </table> | <u>Bits</u> | <u>Description</u> | 6h-0h | Position the read pointer <NbsynPtrAdj, NbsynPtrAdjLo> clock cycles closer to the write pointer. | 7h   | Reserved    |      |             |      |             |      |              |      |          |      |          |      |                 |
| <u>Bits</u> | <u>Description</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |             |                    |       |                                                                                                  |      |             |      |             |      |             |      |              |      |          |      |          |      |                 |
| 6h-0h       | Position the read pointer <NbsynPtrAdj, NbsynPtrAdjLo> clock cycles closer to the write pointer.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |             |                    |       |                                                                                                  |      |             |      |             |      |             |      |              |      |          |      |          |      |                 |
| 7h          | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |             |                    |       |                                                                                                  |      |             |      |             |      |             |      |              |      |          |      |          |      |                 |
| 11          | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |             |                    |       |                                                                                                  |      |             |      |             |      |             |      |              |      |          |      |          |      |                 |

|      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 10:8 | <b>HwPstateMaxVal: P-state maximum value.</b> Read-write. IF (( <a href="#">D18F3xE8[HtcCapable]</a> ==1) && ( <a href="#">D18F3x64[HtcTmpLmt]</a> !=0) && ( <a href="#">D18F3x64[HtcPstateLimit]</a> > HwPstateMaxVal)) THEN BIOS: <a href="#">D18F3x64[HtcPstateLimit]</a> . ENDIF. Cold reset: specified by the reset state of <a href="#">MSRC001_00[6B:64][PstateEn]</a> ; the cold reset value is the highest P-state number corresponding to the MSR in which PstateEn is set (e.g., if <a href="#">MSRC001_0064</a> and <a href="#">MSRC001_0065</a> have this bit set and the others do not, then HwPstateMaxVal=1; if <a href="#">MSRC001_0064</a> has this bit set and the others do not, then HwPstateMaxVal=0). This specifies the highest P-state value (lowest performance state) supported by the hardware. This field must not be written to a value less (higher performance) than <a href="#">MSRC001_0071[CurPstateLimit]</a> . See <a href="#">MSRC001_0061[PstateMaxVal]</a> . This field uses hardware P-state numbering. See <a href="#">2.5.3.1.1.2 [Hardware P-state Numbering]</a> . |
| 7:0  | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |

### D18F3xE4 Thermtrip Status

| Bits | Description                                                                                                                                                                                                                                             |
|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31   | <b>SwThermtp: software THERMTRIP.</b> Write-1-only; cleared-by-hardware. Reset: 0. Writing a 1 to this bit position induces a THERMTRIP event. This bit returns 0 when read. This is a diagnostic bit, and it should be used for testing purposes only. |
| 30:6 | Reserved.                                                                                                                                                                                                                                               |
| 5    | <b>ThermtpEn: THERMTRIP enable.</b> Read-only. Reset: Product-specific. 1=The THERMTRIP state is supported. See <a href="#">2.10.3.3 [THERMTRIP]</a> .                                                                                                  |
| 4    | Reserved.                                                                                                                                                                                                                                               |
| 3    | <b>ThermtpSense: THERMTRIP sense.</b> Read-only. Cold reset: 0. 1=The processor temperature exceeded the THERMTRIP value (regardless as to whether the THERMTRIP state is enabled). This bit is also set when the diagnostic bit SwThermtp = 1.         |
| 2    | Reserved.                                                                                                                                                                                                                                               |
| 1    | <b>Thermtp: THERMTRIP.</b> Read-only. Cold reset: 0. 1=The processor has entered the THERMTRIP state.                                                                                                                                                   |
| 0    | Reserved.                                                                                                                                                                                                                                               |

### D18F3xE8 Northbridge Capabilities

Read-only. Value: Product-specific. Unless otherwise specified, 1=The feature is supported by the processor; 0=The feature is not supported.

| Bits  | Description                                                                             |
|-------|-----------------------------------------------------------------------------------------|
| 31:29 | Reserved.                                                                               |
| 28    | <b>SUCCOR.</b> Read-only. See <a href="#">CPUID Fn8000_0007_EBX[SUCCOR]</a> . Value: 0. |
| 27:26 | Reserved.                                                                               |
| 25    | Reserved.                                                                               |



|       |                                                                                                      |
|-------|------------------------------------------------------------------------------------------------------|
| 24    | <b>MemPstateCap: memory P-state capable.</b>                                                         |
| 23:20 | Reserved.                                                                                            |
| 19    | <b>x2Apic: x2APIC capability.</b><br>Value: 0.                                                       |
| 18:16 | Reserved.                                                                                            |
| 15    | Reserved.                                                                                            |
| 14    | <b>MultVidPlane: multiple VID plane capable.</b> Value: 1.                                           |
| 13:12 | Reserved.                                                                                            |
| 11    | Reserved.                                                                                            |
| 10    | <b>HtcCapable: HTC capable.</b> This affects <a href="#">D18F3x64</a> and <a href="#">D18F3x68</a> . |
| 9     | <b>SvmCapable: SVM capable.</b>                                                                      |
| 8     | <b>MctCap: memory controller (on the processor) capable.</b> Value: 1.                               |
| 7:5   | Reserved.                                                                                            |
| 4     | <b>ChipKill: chipkill ECC capable.</b>                                                               |
| 3     | <b>ECC: ECC capable.</b>                                                                             |
| 2     | <b>EightNode: Eight-node multi-processor capable.</b>                                                |
| 1     | <b>DualNode: Dual-node multi-processor capable.</b>                                                  |
| 0     | Reserved.                                                                                            |

### D18F3xFC CPUID Family/Model/Stepping

[CPUID Fn0000\\_0001\\_EAX](#), [CPUID Fn8000\\_0001\\_EAX](#) are an alias of [D18F3xFC](#).

| Bits  | Description                                                          |
|-------|----------------------------------------------------------------------|
| 31:28 | Reserved.                                                            |
| 27:20 | <b>ExtFamily: extended family.</b> Read-only. Value: 06h.            |
| 19:16 | <b>ExtModel: extended model.</b> Read-only. Value: Product-specific. |
| 15:12 | Reserved.                                                            |
| 11:8  | <b>BaseFamily.</b> Read-only. Reset: Fh.                             |
| 7:4   | <b>BaseModel.</b> Read-only. Value: Product-specific.                |
| 3:0   | <b>Stepping.</b> Read-only. Value: Product-specific.                 |

### D18F3x138 DCT0 Bad Symbol Identification

| Bits | Description |
|------|-------------|
| 31:0 | Reserved.   |

### D18F3x13C DCT1 Bad Symbol Identification

| Bits | Description |
|------|-------------|
| 31:0 | Reserved.   |

### D18F3x140 SRI to XCS Token Count

Out of cold reset, the processor allocates a minimal number of buffers that is smaller than the default values in the register. BIOS must use [D18F0x6C\[RlsLnkFullTokCntImm\]](#) for the values in the register to take effect. This is necessary even if the values are unchanged from the default values.

[D18F3x140](#), [D18F3x144](#), and [D18F3x1\[54:48\]](#) specify the number of XCS (XBAR command scheduler) entries assigned to each virtual channel within each source port. See [2.8 \[Northbridge \(NB\)\]](#).

The default totals are:

Buffer allocation rules:

- The totals of SRI, MCT and the links must not exceed the number of XCS entries.  $XcsSize = 52$ .
  - $SUM(D18F3x140[UpReqTok, UpPreqTok, UpRspTok, DnReqTok, DnPreqTok, DnRspTok, IsocReqTok, IsocPreqTok, IsocRspTok, FreeTok]) + SUM(D18F3x144[ProbeTok, RspTok]) + SUM(D18F3x148[ReqTok0, PReqTok0, RspTok0, ProbeTok0, \{FreeTok[3:2], FreeTok[1:0]\}, IsocReqTok0, IsocPreqTok0, IsocRspTok0, ReqTok1, PReqTok1, RspTok1, ProbeTok1, IsocReqTok1, IsocPreqTok1, IsocRspTok1]) + SUM(D18F3x14C[ReqTok0, PReqTok0, RspTok0, ProbeTok0, \{FreeTok[3:2], FreeTok[1:0]\}, IsocReqTok0, IsocPreqTok0, IsocRspTok0, ReqTok1, PReqTok1, RspTok1, ProbeTok1, IsocReqTok1, IsocPreqTok1, IsocRspTok1]) \leq XcsSize$ . See [D18F3x1\[54:48\]](#).

The defaults for [D18F3x140](#) and [D18F3x1\[54:48\]](#) do not allocate any tokens in the isochronous channel. If isochronous flow control mode (IFCM) is enabled ([D18F0x\[E4,C4,A4,84\]\[IsocEn\]](#)), then the XCS token counts must be changed.

- If IFCM is enabled, then [D18F3x140\[IsocReqTok, IsocRspTok\]](#) must each be non-zero. If isochronous posted requests may be generated in the system, then [D18F3x140\[IsocPreqTok\]](#) must also be non-zero.
- If an IOMMU is present, [D18F3x1\[54:48\]\[IsocReqTok\]](#) must be non-zero.

| Bits  | Description                                                                                                                                                                         |
|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:25 | Reserved.                                                                                                                                                                           |
| 24:20 | <b>FreeTok: free tokens.</b> Read-write.<br>Cold Reset: 0Ch.<br>BIOS: Ch.<br>The number of free tokens must always be greater than or equal to 2 to ensure deadlock free operation. |
| 19:18 | Reserved.                                                                                                                                                                           |
| 17:16 | <b>IsocRspTok: isochronous response tokens.</b> Read-write.<br>Cold Reset: 0.<br>BIOS: 1.                                                                                           |

|       |                                                                                                  |
|-------|--------------------------------------------------------------------------------------------------|
| 15:14 | <b>IsocPreqTok: isochronous posted request tokens.</b> Read-write.<br>Cold Reset: 0.<br>BIOS: 0. |
| 13:12 | <b>IsocReqTok: isochronous request tokens.</b> Read-write.<br>Cold Reset: 0.<br>BIOS: 1.         |
| 11:10 | <b>DnRspTok: downstream response tokens.</b> Read-write.<br>Cold Reset: 1.<br>BIOS: 2.           |
| 9:8   | <b>UpRspTok: upstream response tokens.</b> Read-write.<br>Cold Reset: 3. BIOS: 1.                |
| 7:6   | <b>DnPreqTok: downstream posted request tokens.</b> Read-write. Cold Reset: 1. BIOS: 1.          |
| 5:4   | <b>UpPreqTok: upstream posted request tokens.</b> Read-write. Cold Reset: 1. BIOS: 1.            |
| 3:2   | <b>DnReqTok: downstream request tokens.</b> Read-write.<br>Cold Reset: 1. BIOS: 1.               |
| 1:0   | <b>UpReqTok: upstream request tokens.</b> Read-write.<br>Cold Reset: 3.<br>BIOS: 3.              |

#### D18F3x144 MCT to XCS Token Count

See [D18F3x140](#).

| Bits | Description                                                                 |
|------|-----------------------------------------------------------------------------|
| 31:8 | Reserved.                                                                   |
| 7:4  | <b>ProbeTok: probe tokens.</b> Read-write.<br>Cold Reset: 7h.<br>BIOS: 4h.  |
| 3:0  | <b>RspTok: response tokens.</b> Read-write.<br>Cold Reset: 7h.<br>BIOS: Bh. |

#### D18F3x1[54:48] Link to XCS Token Count

See [D18F3x140](#).

Table 186: [Register Mapping](#) for [D18F3x1\[54:48\]](#)

| Register       | Function       |
|----------------|----------------|
| D18F3x148      | ONION Link     |
| D18F3x14C      | ONIONPlus Link |
| D18F3x1[54:50] | Reserved       |

| Bits  | Description                                                                                                                                                                                          |
|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:30 | <b>FreeTok[3:2]: free tokens.</b> Read-write. Cold reset: 00b.<br>BIOS: 0.<br>See FreeTok[1:0].                                                                                                      |
| 29    | Reserved.                                                                                                                                                                                            |
| 28    | <b>IsocRspTok1: isochronous response tokens sublink 1.</b> Read-write. Cold reset: 0. BIOS: 0.                                                                                                       |
| 27    | Reserved.                                                                                                                                                                                            |
| 26    | <b>IsocPreqTok1: isochronous posted request tokens sublink 1.</b> Read-write. Cold reset: 0. BIOS: 0.                                                                                                |
| 25    | Reserved.                                                                                                                                                                                            |
| 24    | <b>IsocReqTok1: isochronous request tokens sublink 1.</b> Read-write. Cold reset: 0. BIOS: 0.                                                                                                        |
| 23:22 | <b>ProbeTok1: probe tokens sublink 1.</b> Read-write. Cold reset: 0. BIOS: 0.                                                                                                                        |
| 21:20 | <b>RspTok1: response tokens sublink 1.</b> Read-write. Cold reset: 0. BIOS: 0.                                                                                                                       |
| 19:18 | <b>PRReqTok1: posted request tokens sublink 1.</b> Read-write. Cold reset: 0. BIOS: 0.                                                                                                               |
| 17:16 | <b>ReqTok1: request tokens sublink 1.</b> Read-write. Cold reset: 0. BIOS: 0.                                                                                                                        |
| 15:14 | <b>FreeTok[1:0]: free tokens.</b> Read-write. Cold reset: 00b. FreeTok[3:0] = {FreeTok[3:2], FreeTok[1:0]}.<br>BIOS: IF (REG==D18F3x148) THEN 01b ELSE 10b ENDIF.                                    |
| 13:12 | <b>IsocRspTok0: isochronous response tokens sublink 0.</b> Read-write. Cold reset: 0. BIOS: 0.                                                                                                       |
| 11:10 | <b>IsocPreqTok0: isochronous posted request tokens sublink 0.</b> Read-write. Cold reset: 0.<br>BIOS: IF (REG==D18F3x148) THEN 1 ELSE 0 ENDIF.<br>See <a href="#">D18F0x6C</a> [ApplyIsocModeEnNow]. |
| 9:8   | <b>IsocReqTok0: isochronous request tokens sublink 0.</b> Read-write. Cold reset: 0.<br>BIOS: IF (REG==D18F3x148) THEN 1 ELSE 0 ENDIF.                                                               |
| 7:6   | <b>ProbeTok0: probe tokens sublink 0.</b> Read-write. Cold reset: 2.<br>BIOS: 0.                                                                                                                     |
| 5:4   | <b>RspTok0: response tokens sublink 0.</b> Read-write. Cold reset: 2. BIOS: IF (REG==D18F3x148) THEN 2 ELSE 0 ENDIF.                                                                                 |
| 3:2   | <b>PRReqTok0: posted request tokens sublink 0.</b> Read-write. Cold reset: 2. BIOS: IF (REG==D18F3x148) THEN 2 ELSE 0 ENDIF.                                                                         |
| 1:0   | <b>ReqTok0: request tokens sublink 0.</b> Read-write. Cold reset: 2. BIOS: IF (REG==D18F3x148) THEN 2 ELSE 3 ENDIF.                                                                                  |

#### D18F3x160 NB Machine Check Misc (DRAM Thresholding) 0 (MC4\_MISC0)

See [2.15.1 \[Machine Check Architecture\]](#) for a general description of the machine check architecture.  
See [2.15.1.7 \[Error Thresholding\]](#). D18F3x160 is associated with the DRAM error type. See [MSR0000\\_0413](#).

| Bits | Description                                        |
|------|----------------------------------------------------|
| 31   | <b>Valid.</b> Read-only. Reset: 1.                 |
| 30   | <b>CntP: counter present.</b> Read-only. Reset: 1. |

|       |                                                                                                                                            |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------|
| 29    | <b>Locked.</b> Read-only. Reset: 0.                                                                                                        |
| 28:24 | Reserved.                                                                                                                                  |
| 23:20 | <b>LvtOffset: LVT offset.</b> IF (Locked) THEN Read-only. ELSE Read-write. ENDIF. Reset: 0h. BIOS: 1h.                                     |
| 19    | <b>CntEn: counter enable.</b> IF (Locked) THEN Read-only. ELSE Read-write. ENDIF. Reset: 0.                                                |
| 18:17 | <b>IntType: interrupt type.</b> IF (Locked) THEN Read-only. ELSE Read-write. ENDIF. Cold reset: 0.                                         |
| 16    | <b>Ovrflw: overflow.</b> IF (Locked) THEN Read-only; set-by-hardware. ELSE Read-write; set-by-hardware. ENDIF. Cold reset: 0.              |
| 15:12 | Reserved.                                                                                                                                  |
| 11:0  | <b>ErrCnt: error counter.</b> IF (Locked) THEN Read-only; updated-by-hardware. ELSE Read-write; updated-by-hardware. ENDIF. Cold reset: 0. |

### D18F3x168 NB Machine Check Misc (Link Thresholding) 1 (MC4\_MISC1)

See 2.15.1.7 [Error Thresholding]. D18F3x168 is associated with the link error type. See MSRC000\_0408.

| Bits  | Description                                                                                                                                |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------|
| 31    | <b>Valid.</b> Read-only. Reset: 1.                                                                                                         |
| 30    | <b>CntP: counter present.</b> Read-only. Reset: 1.                                                                                         |
| 29    | <b>Locked.</b> Read-only. Reset: 0.                                                                                                        |
| 28:24 | Reserved.                                                                                                                                  |
| 23:20 | <b>LvtOffset: LVT offset.</b> IF (Locked) THEN Read-only. ELSE Read-write. ENDIF. Reset: 0h. BIOS: 1h.                                     |
| 19    | <b>CntEn: counter enable.</b> IF (Locked) THEN Read-only. ELSE Read-write. ENDIF. Reset: 0.                                                |
| 18:17 | <b>IntType: interrupt type.</b> IF (Locked) THEN Read-only. ELSE Read-write. ENDIF. Cold reset: 0.                                         |
| 16    | <b>Ovrflw: overflow.</b> IF (Locked) THEN Read-only; set-by-hardware. ELSE Read-write; set-by-hardware. ENDIF. Cold reset: 0.              |
| 15:12 | Reserved.                                                                                                                                  |
| 11:0  | <b>ErrCnt: error counter.</b> IF (Locked) THEN Read-only; updated-by-hardware. ELSE Read-write; updated-by-hardware. ENDIF. Cold reset: 0. |

### D18F3x17C Extended Freelist Buffer Count

Out of cold reset, the processor allocates a minimal number of buffers that is smaller than the default values in the register. BIOS must use D18F0x6C[RlsLnkFullTokCntImm] for the values in the register to take effect. This is necessary even if the values are unchanged from the default values.

| Bits | Description                                                                                                     |
|------|-----------------------------------------------------------------------------------------------------------------|
| 31:4 | Reserved.                                                                                                       |
| 3:0  | <b>SPQPrbFreeCBC: XBAR to SRI Probe command buffer freelist.</b><br>Cold Reset: 8h.<br>Read-write.<br>BIOS: 8h. |

**D18F3x180 Extended NB MCA Configuration**

Reset: 0000\_0000h. This register is an extension of [D18F3x44 \[MCA NB Configuration\]](#).

| Bits | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31   | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 30   | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 29   | <b>SyncFloodOnDramUncCrcErr</b> : Read-write. 1=Enable generation of SyncFlood on DRAM Uncorrectable CRC Error.                                                                                                                                                                                                                                                                                                                                                         |
| 28   | <b>SyncFloodOnCC6DramUcErr</b> : Read-write. BIOS: 1. 1=Enable generation of SyncFlood when we hit an Uncorrectable ECC error on C6 restore reads.                                                                                                                                                                                                                                                                                                                      |
| 27   | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 26   | <b>ConvertUnCorToCorErrEn: convert uncorrectable error to correctable error enable</b> . Read-write. 1=The status of uncorrectable errors is changed to appear as correctable errors; <a href="#">MSR0000_0411</a> [UC, PCC] are cleared and a machine check exception will not be raised. For uncorrectable ECC errors, <a href="#">MSR0000_0411</a> [UECC] is cleared and <a href="#">MSR0000_0411</a> [CECC] is set. This field is intended for debug observability. |
| 25   | <b>EccSymbolSize: ECC symbol size and code selection</b> . Read-write. BIOS: See <a href="#">2.15.2 [DRAM ECC Considerations]</a> . 0=x4 symbol size and code used. 1=reserved                                                                                                                                                                                                                                                                                          |
| 24   | <b>McaLogErrAddrWdtErr: log error address on WDT errors</b> . Read-write. BIOS: 1. 1=When a watchdog timeout error occurs (see <a href="#">MSR0000_0410</a> [WDTRptEn]), the associated address is logged and <a href="#">MSR0000_0411</a> [AddrV] is set. 0=When a watchdog timeout error occurs, NB state information is saved and <a href="#">MSR0000_0411</a> [AddrV] is cleared. See <a href="#">D18F3x50</a> for details on saved information.                    |
| 23   | <b>SyncFloodOnDramTempErr</b> . Read-write. 1=SyncFlood is generated on a DRAM temp Error.                                                                                                                                                                                                                                                                                                                                                                              |
| 22   | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 21   | <b>SyncFloodOnCpuLeakErr: sync flood on CPU leak error</b> . Read-write. BIOS: 1. 1=Enable sync flood when one of the cores encounters an uncorrectable error which cannot be contained to the process on the core.                                                                                                                                                                                                                                                     |
| 20   | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 19   | <b>PwP2pDatErrRmtPropDis: posted write for remote peer-to-peer data error propagation disable</b> . Read-write.<br>1= A peer-to-peer posted write with a data error is not propagated to the target IO link chain if the target IO link chain is not attached to the local node (the same node as the source IO link chain). Instead, the write is dropped by the host bridge. The state of this field is ignored if SyncFloodOnUsPwDatErr==1 or DatWrErrDeferEn==0.    |

|       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 18    | <b>PwP2pDatErrLclPropDis: posted write for local peer-to-peer data error propagation disable.</b> Read-write. 1=A peer-to-peer posted write with a data error is not propagated to the target IO link chain if the target IO link chain is attached to the local node (the same node as the source IO link chain). Instead, the write is dropped by the host bridge. The state of this field is ignored if SyncFloodOnUsPwDatErr==1 or DatWrErrDeferEn==0.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| 17    | <b>SyncFloodOnDeferErrToIO: convert deferred error for an IO link to sync flood enable.</b> Read-write.<br>BIOS: 1.<br>1=A deferred error which targets an IO link device is turned into a sync flood.<br><ul style="list-style-type: none"> <li>When DramErrDeferEn is set and the read response is for a DMA read with a data error, setting SyncFloodOnDeferErrToIO causes a sync flood.</li> <li>When DatWrErrDeferEn is set and the write is peer-to-peer, setting SyncFloodOnDeferErrToIO causes a sync flood.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                           |
| 16    | <b>DeferDatErrNcHtMcaEn: convert deferred error for an IO link to machine check exception enable.</b> IF (D18F3xE8[SUCCOR]) THEN Read-write. ELSE Read-only. ENDIF.<br>1=A deferred error which targets an IO link device is turned into a machine check exception.<br><ul style="list-style-type: none"> <li>When DramErrDeferEn is set and the read response is for a DMA read with a data error, setting DeferDatErrNcHtMcaEn causes an uncorrected error to be logged and a machine check exception to be generated. An error response is returned to the IO device irrespective of the setting of DeferDatErrNcHtMcaEn.</li> <li>When DatWrErrDeferEn is set and the write is peer-to-peer, setting DeferDatErrNcHtMcaEn causes an uncorrected error to be logged and a machine check exception to be generated. An error indication is sent to the target IO device irrespective of the setting of DeferDatErrNcHtMcaEn.</li> </ul> |
| 15    | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| 14:11 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| 10    | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| 9     | <b>SyncFloodOnUCNbAry: sync flood on UC NB array error.</b> Read-write. BIOS: 1. 1=Enable sync flood on detection of an UC error in an NB array.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 8     | <b>SyncFloodOnProtErr: sync flood on protocol error.</b> Read-write. BIOS: 1. 1=Enable sync flood on detection of link protocol error, L3 protocol error, and probe filter protocol error.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| 7     | <b>SyncFloodOnTgtAbortErr.</b> Read-write. BIOS: 1. 1=Enable sync flood on generated or received link responses that indicate target aborts.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| 6     | <b>SyncFloodOnDatErr.</b> Read-write.<br>BIOS: 1.<br>1=Enable sync flood on generated or received link responses that indicate data error.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| 5     | <b>DisPciCfgCpuMstAbortRsp.</b> Read-write. BIOS: 1. 1=For master abort responses to CPU-initiated configuration accesses, disables MCA error reporting and generation of an error response to the core. It is recommended that this bit be set in order to avoid MCA exceptions being generated from master aborts for PCI configuration accesses, which are common during device enumeration.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 4     | <b>ChgMstAbortToNoErr.</b> Read-write. 1=Signal no errors instead of master abort in link response packets to IO devices on detection of a master abort condition. When ChgMstAbortToNoErr and D18F3x44[IoMstAbortDis] are both set, ChgMstAbortToNoErr takes precedence.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| 3     | <b>ChgDatErrToTgtAbort.</b> Read-write. 1=Signal target abort instead of data error in link response packets to IO devices (for Gen1 link compatibility).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| 2     | <b>WDTCntSel[3]: watchdog timer count select bit[3].</b> Read-write. See D18F3x44[WDTCntSel].                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |

|   |                                                                                                                                                                                                                                  |
|---|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | <b>SyncFloodOnUsPwDatErr: sync flood on upstream posted write data error.</b> Read-write. BIOS: 1. 1=Enable sync flood generation when an upstream posted write data error is detected.                                          |
| 0 | <b>McaLogUsPwDatErrEn: MCA log of upstream posted write data error enable.</b> Read-write. BIOS: 1. 1=Enable logging of upstream posted write data errors in MCA (if NB MCA registers are appropriately enabled and configured). |

## D18F3x188 NB Configuration 2

Same-for-all.

| Bits  | Description                                                                                                                                   |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------|
| 31:28 | Reserved.                                                                                                                                     |
| 27    | <b>DisCpuWrSzDw64ReOrd: disable streaming store reorder.</b> Read-write. Reset: 1. BIOS: 1. 1=Disable reordering of streaming store commands. |
| 26:10 | Reserved.                                                                                                                                     |
| 9     | <b>DisL3HiPriFreeListAlloc.</b> Read-write. Reset: 0. BIOS: 1. 1=Disables normal SRQ entry scheme which gives higher priority to XBAR.        |
| 8:0   | Reserved.                                                                                                                                     |

## D18F3x190 Downcore Control

Cold reset: 0000\_0000h. See 2.4.4 [Processor Cores and Downcoring] and 2.4.4.1 [Software Downcoring using D18F3x190[DisCore]].

| Bits   | Description                                                                                                                                                                                                                                                                                                             |     |             |     |         |       |             |     |         |        |           |
|--------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-------------|-----|---------|-------|-------------|-----|---------|--------|-----------|
| 31:0   | <b>DisCore.</b> Read-write; reset-applied. 0=Core enabled. 1=Core disabled.<br><table> <tr> <th>Bit</th><th>Description</th></tr> <tr> <td>[0]</td><td>Core 0.</td></tr> <tr> <td>[2:1]</td><td>Core &lt;BIT&gt;.</td></tr> <tr> <td>[3]</td><td>Core 3.</td></tr> <tr> <td>[31:4]</td><td>Reserved.</td></tr> </table> | Bit | Description | [0] | Core 0. | [2:1] | Core <BIT>. | [3] | Core 3. | [31:4] | Reserved. |
| Bit    | Description                                                                                                                                                                                                                                                                                                             |     |             |     |         |       |             |     |         |        |           |
| [0]    | Core 0.                                                                                                                                                                                                                                                                                                                 |     |             |     |         |       |             |     |         |        |           |
| [2:1]  | Core <BIT>.                                                                                                                                                                                                                                                                                                             |     |             |     |         |       |             |     |         |        |           |
| [3]    | Core 3.                                                                                                                                                                                                                                                                                                                 |     |             |     |         |       |             |     |         |        |           |
| [31:4] | Reserved.                                                                                                                                                                                                                                                                                                               |     |             |     |         |       |             |     |         |        |           |

## D18F3x1A0 Core Interface Buffer Count

Out of cold reset, the processor allocates a minimal number of buffers that is smaller than the default values in the register. BIOS must use D18F0x6C[RlsLnkFullTokCntImm] for the values in the register to take effect. This is necessary even if the values are unchanged from the default values.

- The following buffer allocations rules must be satisfied:
  - CpuCmdBufCnt >= 2.

| Bits | Description |
|------|-------------|
| 31   | Reserved.   |



| 30:26   | <b>NbToCpuPrbLmt.</b> Read-write. Reset: 0Fh. BIOS:Ch. Maximum number of outstanding probes to the compute-unit.<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>02h-00h</td><td>Reserved</td></tr> <tr> <td>0Fh-03h</td><td>Maximum of &lt;NbToCpuPrbLmt&gt; probes.</td></tr> <tr> <td>1Fh-10h</td><td>Reserved</td></tr> </table> | Bits | Description | 02h-00h | Reserved                           | 0Fh-03h | Maximum of <NbToCpuPrbLmt> probes. | 1Fh-10h | Reserved |
|---------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|---------|------------------------------------|---------|------------------------------------|---------|----------|
| Bits    | Description                                                                                                                                                                                                                                                                                                                                          |      |             |         |                                    |         |                                    |         |          |
| 02h-00h | Reserved                                                                                                                                                                                                                                                                                                                                             |      |             |         |                                    |         |                                    |         |          |
| 0Fh-03h | Maximum of <NbToCpuPrbLmt> probes.                                                                                                                                                                                                                                                                                                                   |      |             |         |                                    |         |                                    |         |          |
| 1Fh-10h | Reserved                                                                                                                                                                                                                                                                                                                                             |      |             |         |                                    |         |                                    |         |          |
| 25:24   | Reserved.                                                                                                                                                                                                                                                                                                                                            |      |             |         |                                    |         |                                    |         |          |
| 23:20   | <b>NbToCpuDatReqLmt.</b> Read-write. Reset: Ch. Octword outstanding per core limit.<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>Ch-0h</td><td>Octword outstanding per core limit</td></tr> <tr> <td>Fh-Dh</td><td>Reserved</td></tr> </table>                                                                                    | Bits | Description | Ch-0h   | Octword outstanding per core limit | Fh-Dh   | Reserved                           |         |          |
| Bits    | Description                                                                                                                                                                                                                                                                                                                                          |      |             |         |                                    |         |                                    |         |          |
| Ch-0h   | Octword outstanding per core limit                                                                                                                                                                                                                                                                                                                   |      |             |         |                                    |         |                                    |         |          |
| Fh-Dh   | Reserved                                                                                                                                                                                                                                                                                                                                             |      |             |         |                                    |         |                                    |         |          |
| 19      | Reserved.                                                                                                                                                                                                                                                                                                                                            |      |             |         |                                    |         |                                    |         |          |
| 18:16   | <b>CpuToNbFreeBufCnt.</b> Read-write. Cold Reset: 2h. Provides the number of tokens which can be released to each compute unit from the freelist pool. This field can be updated at any time by BIOS and does not require a warm reset to take effect.<br>BIOS: 11b.                                                                                 |      |             |         |                                    |         |                                    |         |          |
| 15:12   | Reserved. Cold reset: 4h.                                                                                                                                                                                                                                                                                                                            |      |             |         |                                    |         |                                    |         |          |
| 11:10   | Reserved.                                                                                                                                                                                                                                                                                                                                            |      |             |         |                                    |         |                                    |         |          |
| 9:4     | Reserved. Cold reset: Product-specific.                                                                                                                                                                                                                                                                                                              |      |             |         |                                    |         |                                    |         |          |
| 3       | Reserved.                                                                                                                                                                                                                                                                                                                                            |      |             |         |                                    |         |                                    |         |          |
| 2:0     | <b>CpuCmdBufCnt: CPU to SRI command buffer count.</b> Read-write; reset-applied. Each compute unit is allocated the number of buffers specified by this field.<br><br>Cold Reset: 2h.<br>BIOS: 1h.                                                                                                                                                   |      |             |         |                                    |         |                                    |         |          |

### D18F3x1CC IBS Control

Reset: 0000\_0000h. [MSRC001\\_103A](#) is an alias of [D18F3x1CC](#). [D18F3x1CC](#) is programmed by BIOS; The OS reads the LVT offset from [MSRC001\\_103A](#).

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                         |      |             |       |                                     |       |          |
|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|-------|-------------------------------------|-------|----------|
| 31:9  | Reserved.                                                                                                                                                                                                                                                                                                                                                           |      |             |       |                                     |       |          |
| 8     | <b>LvtOffsetVal: local vector table offset valid.</b> Read-write. BIOS: 1. 1=The offset in LvtOffset is valid. 0=The offset in LvtOffset is not valid and IBS interrupt generation is disabled.                                                                                                                                                                     |      |             |       |                                     |       |          |
| 7:4   | Reserved.                                                                                                                                                                                                                                                                                                                                                           |      |             |       |                                     |       |          |
| 3:0   | <b>LvtOffset: local vector table offset.</b> Read-write. BIOS: 0h. Specifies the address of the IBS LVT entry in the APIC registers. See <a href="#">APIC[530:500]</a> .<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>3h-0h</td><td>LVT address = &lt;500h + LvtOffset&lt;&lt;4&gt;</td></tr> <tr> <td>Fh-4h</td><td>Reserved</td></tr> </table> | Bits | Description | 3h-0h | LVT address = <500h + LvtOffset<<4> | Fh-4h | Reserved |
| Bits  | Description                                                                                                                                                                                                                                                                                                                                                         |      |             |       |                                     |       |          |
| 3h-0h | LVT address = <500h + LvtOffset<<4>                                                                                                                                                                                                                                                                                                                                 |      |             |       |                                     |       |          |
| Fh-4h | Reserved                                                                                                                                                                                                                                                                                                                                                            |      |             |       |                                     |       |          |

**D18F3x1FC Product Information Register 1**

| Bits  | Description                                                                                                                                                                              |
|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:22 | Reserved.                                                                                                                                                                                |
| 21    | <b>VddrLowVoltageSupport</b> . Value: Product-specific. 1=BIOS sets VDDR and VDDP voltage to 0.95V, limits DRAM rate to 1600, and limits PCIe to Gen2. 0=Default VDDR and VDDP voltages. |
| 20:17 | <b>DiDtCfg4</b> . Value: Product-specific. See <a href="#">MSRC001_1028</a> [DiDtCfg4].                                                                                                  |
| 16    | <b>DiDtCfg3</b> . Value: Product-specific. See <a href="#">MSRC001_1028</a> [DiDtCfg3].                                                                                                  |
| 15:14 | <b>DiDtCfg2</b> . Value: Product-specific. See <a href="#">MSRC001_1028</a> [DiDtCfg2].                                                                                                  |
| 13:6  | <b>DiDtCfg1</b> . Value: Product-specific. See <a href="#">MSRC001_1028</a> [DiDtCfg1].                                                                                                  |
| 5:1   | <b>DiDtCfg0</b> . Value: Product-specific. See <a href="#">MSRC001_1028</a> [DiDtCfg0].                                                                                                  |
| 0     | <b>DiDtMode</b> . Value: Product-specific. See <a href="#">MSRC001_1028</a> [DiDtMode].                                                                                                  |

**D18F3x200 Performance Mode Control Register**

| Bits | Description                                                                                                                                                                        |
|------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:8 | Reserved.                                                                                                                                                                          |
| 7:4  | <b>EnCpuSkidBufFull</b> . Read-write. Reset: 0. Enables optimal use of the CPU skid buffers, in the presence of multiple data movement requests from the same core.                |
| 3    | <b>EnMcqPrbPickThrottle</b> . Read-write. Reset: 0. BIOS: 1. 1=Enabling throttling the MCQ to ensure the bypass path is taken by the probes instead of allocating in to the XCS.   |
| 2    | <b>EnDctOddToNcLnkDatXfr</b> . Read-write. Reset: 0. BIOS: 1. 1=Enables direct transfer of data from odd-numbered DRAM channels (1,3,..) to non-coherent links on the local node.  |
| 1    | <b>EnDctEvnToNcLnkDatXfr</b> . Read-write. Reset: 0. BIOS: 1. 1=Enables direct transfer of data from even-numbered DRAM channels (0,2,..) to non-coherent links on the local node. |
| 0    | Reserved.                                                                                                                                                                          |

**D18F3x238 DCT2 Bad Symbol Identification**

| Bits | Description |
|------|-------------|
| 31:0 | Reserved.   |

**D18F3x23C DCT3 Bad Symbol Identification**

| Bits | Description |
|------|-------------|
| 31:0 | Reserved.   |

**D18F3x2B4 DCT and Fuse Power Gate Control**

See [2.5.4.3 \[Fuse Power Gating\]](#).

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |      |             |     |          |     |            |     |             |     |             |
|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|-----|----------|-----|------------|-----|-------------|-----|-------------|
| 31:27 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |      |             |     |          |     |            |     |             |     |             |
| 26    | <b>FusePwrStatus.</b> Read-only. Cold reset: 0. Specifies whether fuses are power-gated. 1=Fuses are powered. 0=Fuses are powered-down.                                                                                                                                                                                                                                                                                                                                                                                                                                                            |      |             |     |          |     |            |     |             |     |             |
| 25:24 | <b>PwrDnHyst.</b> Read-write. Cold reset: 00b. Specifies the minimum amount of time that must expire with no fuse power up events before fuse power gating is initiated. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>10 us</td></tr> <tr> <td>01b</td><td>32 us</td></tr> <tr> <td>10b</td><td>128 us</td></tr> <tr> <td>11b</td><td>Reserved.</td></tr> </table>                                                                                                                                                                                                     | Bits | Description | 00b | 10 us    | 01b | 32 us      | 10b | 128 us      | 11b | Reserved.   |
| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |      |             |     |          |     |            |     |             |     |             |
| 00b   | 10 us                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |      |             |     |          |     |            |     |             |     |             |
| 01b   | 32 us                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |      |             |     |          |     |            |     |             |     |             |
| 10b   | 128 us                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |      |             |     |          |     |            |     |             |     |             |
| 11b   | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |      |             |     |          |     |            |     |             |     |             |
| 23:22 | <b>PostPwrDnDelay.</b> Read-write. Cold reset: 00b. Specifies the amount of time between the completion of fuse power gating and the start of a new fuse power operation. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>1 RefClk</td></tr> <tr> <td>01b</td><td>64 RefClks</td></tr> <tr> <td>10b</td><td>128 RefClks</td></tr> <tr> <td>11b</td><td>256 RefClks</td></tr> </table>                                                                                                                                                                                     | Bits | Description | 00b | 1 RefClk | 01b | 64 RefClks | 10b | 128 RefClks | 11b | 256 RefClks |
| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |      |             |     |          |     |            |     |             |     |             |
| 00b   | 1 RefClk                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |      |             |     |          |     |            |     |             |     |             |
| 01b   | 64 RefClks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |      |             |     |          |     |            |     |             |     |             |
| 10b   | 128 RefClks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |      |             |     |          |     |            |     |             |     |             |
| 11b   | 256 RefClks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |      |             |     |          |     |            |     |             |     |             |
| 21:20 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |      |             |     |          |     |            |     |             |     |             |
| 19:18 | <b>PostPwrUpDelay.</b> Read-write. Cold reset: 00b. Specifies the amount of time between the completion of fuse power ungating and the start of a new fuse power operation. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>1 RefClk</td></tr> <tr> <td>01b</td><td>Reserved.</td></tr> <tr> <td>10b</td><td>Reserved.</td></tr> <tr> <td>11b</td><td>Reserved.</td></tr> </table>                                                                                                                                                                                        | Bits | Description | 00b | 1 RefClk | 01b | Reserved.  | 10b | Reserved.   | 11b | Reserved.   |
| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |      |             |     |          |     |            |     |             |     |             |
| 00b   | 1 RefClk                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |      |             |     |          |     |            |     |             |     |             |
| 01b   | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |      |             |     |          |     |            |     |             |     |             |
| 10b   | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |      |             |     |          |     |            |     |             |     |             |
| 11b   | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |      |             |     |          |     |            |     |             |     |             |
| 17:16 | <b>PrePwrUpDelay.</b> Read-write. Cold reset: 00b. Specifies the amount of time between a power up event and the start of fuse power ungating. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>1 RefClk</td></tr> <tr> <td>01b</td><td>Reserved.</td></tr> <tr> <td>10b</td><td>Reserved.</td></tr> <tr> <td>11b</td><td>Reserved.</td></tr> </table>                                                                                                                                                                                                                     | Bits | Description | 00b | 1 RefClk | 01b | Reserved.  | 10b | Reserved.   | 11b | Reserved.   |
| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |      |             |     |          |     |            |     |             |     |             |
| 00b   | 1 RefClk                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |      |             |     |          |     |            |     |             |     |             |
| 01b   | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |      |             |     |          |     |            |     |             |     |             |
| 10b   | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |      |             |     |          |     |            |     |             |     |             |
| 11b   | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |      |             |     |          |     |            |     |             |     |             |
| 15:12 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |      |             |     |          |     |            |     |             |     |             |
| 11:8  | <b>DctClkGateEn.</b> Read-write. Cold reset: 0h. BIOS: 6h. 1=Enable DCT clock gating. 0=Disable DCT clock gating. [0]=DCT 0; ...; [3]=DCT 3. Once clock gating has been enabled, it cannot be disabled without a cold reset.                                                                                                                                                                                                                                                                                                                                                                       |      |             |     |          |     |            |     |             |     |             |
| 7:4   | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |      |             |     |          |     |            |     |             |     |             |
| 3:0   | <b>DctPwrGateEn.</b> Read-write. Cold reset: 0h. BIOS: 6h. 1=Enable static DCT power gating. 0=Disable static DCT power gating. [0]=DCT 0; ...; [3]=DCT 3. There are two power islands in the DCT, one for DCT 0 and 3, and another for DCT 1 and 2. An island is only power gated if power gating is enabled for all DCTs on the power island. An island is physically power gated when the northbridge enters its NB C-state, and remain so if configured properly with DctPwrGateEn. For any given DCT, DctClkGateEn is required to be set prior to or in parallel with DctPwrGateEn being set. |      |             |     |          |     |            |     |             |     |             |

### 3.13 Device 18h Function 4 Configuration Registers

See 3.1 [Register Descriptions and Mnemonics]. See 2.7 [Configuration Space].

#### D18F4x00 Device/Vendor ID

| Bits  | Description                                          |
|-------|------------------------------------------------------|
| 31:16 | <b>DeviceID:</b> device ID. Read-only. Value: 141Eh. |
| 15:0  | <b>VendorID:</b> vendor ID. Read-only. Value: 1022h. |

#### D18F4x04 Status/Command

| Bits  | Description                                                                                                                                                                                                                                                                                                           |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:16 | <b>Status.</b> Read-only. Reset: 0000_0000_000X_0000b. Only Status[4] may be set to indicate the existence of a PCI-defined capability block. 0=No supported links are ungang. 1=At least one link may be ungang, in which case there is a capability block associated with sublink one of the link in this function. |
| 15:0  | <b>Command.</b> Read-only. Value: 0000h.                                                                                                                                                                                                                                                                              |

#### D18F4x08 Class Code/Revision ID

Reset: 0600\_0000h.

| Bits | Description                                                                                           |
|------|-------------------------------------------------------------------------------------------------------|
| 31:8 | <b>ClassCode.</b> Read-only. Provides the host bridge class code as defined in the PCI specification. |
| 7:0  | <b>RevID:</b> revision ID. Read-only.                                                                 |

#### D18F4x0C Header Type

Reset: 0080\_0000h.

| Bits | Description                                                                                                                                                              |
|------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:0 | <b>HeaderTypeReg.</b> Read-only. These bits are fixed at their default values. The header type field indicates that there are multiple functions present in this device. |

#### D18F4x34 Capabilities Pointer

| Bits | Description                                                 |
|------|-------------------------------------------------------------|
| 31:8 | Reserved.                                                   |
| 7:0  | <b>CapPtr:</b> capabilities pointer. Read-only. Value: 00h. |

**D18F4x110 Sample and Residency Timers**

| Bits  | Description                                                                                                                                                                                                                                                                                                                                          |
|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:21 | Reserved.                                                                                                                                                                                                                                                                                                                                            |
| 20:13 | <b>MinResTmr: minimum residency timer.</b> IF <a href="#">D18F4x15C</a> [BoostLock] THEN Read-only. ELSE Read-write. ENDIF. Cold reset: Product-specific.<br>Specifies the minimum amount of time required between TDP-initiated P-state transitions. The minimum amount of time is defined as MinResTmr * CSampleTimer * 5.12us .                   |
| 12    | Reserved.                                                                                                                                                                                                                                                                                                                                            |
| 11:0  | <b>CSampleTimer.</b><br>IF <a href="#">D18F4x15C</a> [BoostLock] THEN Read-only. ELSE Read-write. Cold reset: 0.<br>Specifies the value that the internal CSampleTimer counter must increment to before expiring. When the internal CSampleTimer counter expires, it is reset to 0. See <a href="#">2.5.9 [Application Power Management (APM)]</a> . |

**D18F4x11[C:8] C-state Control**

[D18F4x11\[C:8\]](#) consist of three identical 16-bit registers, one for each C-state Action Field (CAF) associated with an IO address that is read to enter C-states. Refer to [2.5.3.2 \[Core C-states\]](#).

- [D18F4x118](#)[15:0] specifies the actions attempted by the core when software reads from the IO address specified by [MSRC001\\_0073](#)[CstateAddr].
- [D18F4x118](#)[31:16] specifies the actions attempted by the core when software reads from the IO address specified by [MSRC001\\_0073](#)[CstateAddr]+1.
- [D18F4x11C](#)[15:0] specifies the actions attempted by the core when software reads from the IO address specified by [MSRC001\\_0073](#)[CstateAddr]+2.

**D18F4x118 C-state Control 1**

| Bits  | Description                                                                                                                                                                                           |
|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:30 | Reserved.                                                                                                                                                                                             |
| 29    | <b>SelfRefrEarly1.</b> Read-write. Reset: 0. See: SelfRefrEarly0. BIOS: 0.                                                                                                                            |
| 28    | <b>SelfRefr1.</b> Read-write. Reset: 0. See: SelfRefr0. BIOS: 1.                                                                                                                                      |
| 27    | <b>NbClkGate1.</b> Read-write. Reset: 0. See: NbClkGate0. BIOS: 1.                                                                                                                                    |
| 26    | <b>NbPwrGate1.</b> Read-write. Reset: 0. See: NbPwrGate0.<br>IF ( <a href="#">CPUID Fn8000_0001_EBX</a> [PkgType] ==1) THEN BIOS: 0. ELSE BIOS: 1. ENDIF. See <a href="#">2.5.4.2 [NB C-states]</a> . |
| 25    | <b>PwrOffEnCstAct1.</b> Read-write; updated-by-SMU. Reset: 0. See: PwrOffEnCstAct0. BIOS: 1.                                                                                                          |

|       |                                                                                                                                                                                                                                                                                                                                                                                               |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 24    | <b>PwrGateEnCstAct1</b> . Read-write. Reset: 0. See: PwrGateEnCstAct0. BIOS: 1.                                                                                                                                                                                                                                                                                                               |
| 23:21 | <b>ClkDivisorCstAct1</b> . Read-write. Reset: 0. See: ClkDivisorCstAct0. BIOS: 000b.                                                                                                                                                                                                                                                                                                          |
| 20    | Reserved.                                                                                                                                                                                                                                                                                                                                                                                     |
| 19:18 | <b>CacheFlushTmrSelCstAct1</b> . Read-write. Reset: 0. See: CacheFlushTmrSelCstAct0. BIOS: 01b.                                                                                                                                                                                                                                                                                               |
| 17    | <b>CacheFlushEnCstAct1</b> . Read-write. Reset: 0. See: CacheFlushEnCstAct0. BIOS: 1.                                                                                                                                                                                                                                                                                                         |
| 16    | <b>CpuPrbEnCstAct1</b> . Read-write. Reset: 0. See: CpuPrbEnCstAct0. BIOS: 1.                                                                                                                                                                                                                                                                                                                 |
| 15:14 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                     |
| 13    | <b>SelfRefrEarly0: allow early self-refresh</b> . Read-write. Reset: 0. BIOS: 0. 1=Allow self-refresh while cores in PC1 or CC1 are waiting for the cache flush timer to expire. 0=Wait for cache flush timer to expire before allowing self-refresh. See <a href="#">2.5.7.2 [DRAM Self-Refresh]</a> and <a href="#">2.5.3.2.3.1 [C-state Probes and Cache Flushing]</a> .                   |
| 12    | <b>SelfRefr0: self-refresh</b> . Read-write. Reset: 0. BIOS: 1.<br>1=Allow DRAM self-refresh while in NB C-states. 0=Prevent DRAM self-refresh while in NB C-states. NbClkGate0 must be equal to SelfRefr0. See <a href="#">2.5.7.2 [DRAM Self-Refresh]</a> and <a href="#">2.5.4.2 [NB C-states]</a> .                                                                                       |
| 11    | <b>NbClkGate0: NB clock-gating</b> . Read-write. Reset: 0. BIOS: 1.<br>1=Allow clock-gating of the NB. 0=Prevent clock-gating of the NB. NbClkGate0 must be equal to SelfRefr0. See <a href="#">2.5.4.2 [NB C-states]</a> .                                                                                                                                                                   |
| 10    | <b>NbPwrGate0: NB power-gating</b> . Read-write. Reset: 0.<br>IF (CPUID Fn8000_0001_EBX[PkgType] ==1) THEN BIOS: 0. ELSE BIOS: 1. ENDIF. See <a href="#">2.5.4.2 [NB C-states]</a> .<br>1=Allow power-gating of the NB. 0=Prevent power-gating of the NB. NbPwrGate0 can only be programmed to 1 if NbClkGate0 and SelfRefr0 are programmed to 1. See <a href="#">2.5.4.2 [NB C-states]</a> . |
| 9     | <b>PwrOffEnCstAct0: power off enable</b> . Read-write; updated-by-SMU. Reset: 0. BIOS: 1.<br>1=Package power off enable. CacheFlushEnCstAct0 is required to be set if this bit is set. PwrGateEnCstAct0 is required to be set if this bit is set. See <a href="#">2.5.3.2.3.4 [Package C6 (PC6) State]</a> .                                                                                  |
| 8     | <b>PwrGateEnCstAct0: power gate enable</b> . Read-write. Reset: 0. BIOS: 1. 1=Core power gating is enabled. CacheFlushEnCstAct0 is required to be set if this bit is set. See <a href="#">2.5.3.2.3.3 [Core C6 (CC6) State]</a> .                                                                                                                                                             |

| 7:5  | <p><b>ClkDivisorCstAct0: clock divisor.</b> Read-write. Reset: 0. BIOS: 000b.</p> <p>Specifies the core clock frequency while in the low-power state before the caches are flushed. This divisor is relative to the current FID frequency, or:</p> <ul style="list-style-type: none"><li>100 MHz * (10h + MSRC001_00[6B:64][CpuFid]) of the current P-state specified by MSRC001_0063[CurPstate].</li></ul> <p>If MSRC001_00[6B:64][CpuDid] of the current P-state indicates a divisor that is deeper than specified by this field, then no frequency change is made when entering the low-power state associated with this register.</p> <table><tr><th>Bits</th><th>Description</th><th>Bits</th><th>Description</th></tr><tr><td>000b</td><td>/1</td><td>100b</td><td>/16</td></tr><tr><td>001b</td><td>/2</td><td>101b</td><td>/128</td></tr><tr><td>010b</td><td>/4</td><td>110b</td><td>/512</td></tr><tr><td>011b</td><td>/8</td><td>111b</td><td>Turn off clocks.</td></tr></table> <p>See CacheFlushTmrSelCstAct0.</p>                                                                                                                                                                                                                                                                       | Bits | Description       | Bits | Description | 000b | /1                            | 100b | /16                      | 001b | /2       | 101b | /128 | 010b | /4 | 110b | /512 | 011b | /8 | 111b | Turn off clocks. |
|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------------|------|-------------|------|-------------------------------|------|--------------------------|------|----------|------|------|------|----|------|------|------|----|------|------------------|
| Bits | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Bits | Description       |      |             |      |                               |      |                          |      |          |      |      |      |    |      |      |      |    |      |                  |
| 000b | /1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 100b | /16               |      |             |      |                               |      |                          |      |          |      |      |      |    |      |      |      |    |      |                  |
| 001b | /2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 101b | /128              |      |             |      |                               |      |                          |      |          |      |      |      |    |      |      |      |    |      |                  |
| 010b | /4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 110b | /512              |      |             |      |                               |      |                          |      |          |      |      |      |    |      |      |      |    |      |                  |
| 011b | /8                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 111b | Turn off clocks.  |      |             |      |                               |      |                          |      |          |      |      |      |    |      |      |      |    |      |                  |
| 4    | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |      |                   |      |             |      |                               |      |                          |      |          |      |      |      |    |      |      |      |    |      |                  |
| 3:2  | <p><b>CacheFlushTmrSelCstAct0: cache flush timer select.</b> Read-write. Reset: 0. BIOS: 10b. Specifies the timer to use for cache flush.</p> <table><tr><th>Bits</th><th>Cache flush timer</th></tr><tr><td>00b</td><td>0 us</td></tr><tr><td>01b</td><td>D18F3xDC[CacheFlushOnHaltTmr]</td></tr><tr><td>10b</td><td>D18F4x128[CacheFlushTmr]</td></tr><tr><td>11b</td><td>Reserved</td></tr></table> <p>Each compute unit has one timer that is shared by all cores within the compute-unit. D18F3xDC[CacheFlushOnHaltCtl] specifies the core clock divisor to use after the caches are flushed. Writing values greater than 10b result in 10b. See CacheFlushEnCstAct0 and CpuPrbEnCstAct0.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Bits | Cache flush timer | 00b  | 0 us        | 01b  | D18F3xDC[CacheFlushOnHaltTmr] | 10b  | D18F4x128[CacheFlushTmr] | 11b  | Reserved |      |      |      |    |      |      |      |    |      |                  |
| Bits | Cache flush timer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |      |                   |      |             |      |                               |      |                          |      |          |      |      |      |    |      |      |      |    |      |                  |
| 00b  | 0 us                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |      |                   |      |             |      |                               |      |                          |      |          |      |      |      |    |      |      |      |    |      |                  |
| 01b  | D18F3xDC[CacheFlushOnHaltTmr]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |      |                   |      |             |      |                               |      |                          |      |          |      |      |      |    |      |      |      |    |      |                  |
| 10b  | D18F4x128[CacheFlushTmr]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |      |                   |      |             |      |                               |      |                          |      |          |      |      |      |    |      |      |      |    |      |                  |
| 11b  | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |      |                   |      |             |      |                               |      |                          |      |          |      |      |      |    |      |      |      |    |      |                  |
| 1    | <p><b>CacheFlushEnCstAct0: cache flush enable.</b> Read-write. Reset: 0. BIOS: 1. 1=Cache flush enable. The cache flush timer starts counting when the C-state is entered. See CacheFlushTmrSelCstAct0 and 2.5.3.2.3.1 [C-state Probes and Cache Flushing].</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |      |                   |      |             |      |                               |      |                          |      |          |      |      |      |    |      |      |      |    |      |                  |
| 0    | <p><b>CpuPrbEnCstAct0: core direct probe enable.</b> Read-write. Reset: 0. BIOS: 1. Specifies how probes are handled while in the low-power state. 0=When the probe request comes into the NB, the core clock is brought up to the COF (based on the current P-state), all outstanding probes are completed, the core waits for a hysteresis time based on D18F3xD4[ClkRampHystSel], and then the core clock is brought down to the frequency specified by ClkDivisorCstAct0. 1=The core clock does not change frequency; the probe is handled at the frequency specified by ClkDivisorCstAct0; this may only be set if:</p> <ul style="list-style-type: none"><li>ClkDivisorCstAct0 specifies a divide-by 1, 2, 4, 8, or 16 and NbCof &lt;= 3.2 GHz</li><li>ClkDivisorCstAct0 specifies a divide-by 1, 2, 4, or 8 and NbCof &gt;= 3.4 GHz</li></ul> <p>This bit also specifies functionality of the timer used for cache flushing. See CacheFlushTmrSelCstAct0.</p> <ul style="list-style-type: none"><li>If CpuPrbEnCstAct0=0 and D18F3xDC[IgnCpuPrbEn]=0, only the time when the core is in a non-C0 state and has its clocks ramped up to service probes is counted.</li><li>If CpuPrbEnCstAct0=1 or D18F3xDC[IgnCpuPrbEn]=1, all of the time the core is in a non-C0 state is counted.</li></ul> |      |                   |      |             |      |                               |      |                          |      |          |      |      |      |    |      |      |      |    |      |                  |

## D18F4x11C C-state Control 2

Reset: 0000\_0000h. Read-write.

| Bits  | Description                                                                                                                                                                                                                                                                          |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:14 | Reserved.                                                                                                                                                                                                                                                                            |
| 13    | <b>SelfRefrEarly2</b> . See: <a href="#">D18F4x118[SelfRefrEarly0]</a> .                                                                                                                                                                                                             |
| 12    | <b>SelfRefr2</b> . See: <a href="#">D18F4x118[SelfRefr0]</a> .                                                                                                                                                                                                                       |
| 11    | <b>NbClkGate2</b> . See: <a href="#">D18F4x118[NbClkGate0]</a> .                                                                                                                                                                                                                     |
| 10    | <b>NbPwrGate2</b> . Read-write. IF ( <a href="#">CPUID Fn8000_0001_EBX</a> [PkgType] ==1) THEN BIOS: 0. ELSE BIOS: 1. ENDIF.<br>1=Allow clock-gating of the NB. 0=Prevent clock-gating of the NB. NbClkGate2 must be equal to SelfRefr2. See <a href="#">2.5.4.2 [NB C-states]</a> . |
| 9     | <b>PwrOffEnCstAct2</b> . See: <a href="#">D18F4x118[PwrOffEnCstAct0]</a> .                                                                                                                                                                                                           |
| 8     | <b>PwrGateEnCstAct2</b> . See: <a href="#">D18F4x118[PwrGateEnCstAct0]</a> .                                                                                                                                                                                                         |
| 7:5   | <b>ClkDivisorCstAct2</b> . See: <a href="#">D18F4x118[ClkDivisorCstAct0]</a> .                                                                                                                                                                                                       |
| 4     | Reserved.                                                                                                                                                                                                                                                                            |
| 3:2   | <b>CacheFlushTmrSelCstAct2</b> . See: <a href="#">D18F4x118[CacheFlushTmrSelCstAct0]</a> .                                                                                                                                                                                           |
| 1     | <b>CacheFlushEnCstAct2</b> . See: <a href="#">D18F4x118[CacheFlushEnCstAct0]</a> .                                                                                                                                                                                                   |
| 0     | <b>CpuPrbEnCstAct2</b> . See: <a href="#">D18F4x118[CpuPrbEnCstAct0]</a> .                                                                                                                                                                                                           |

#### D18F4x124 C-state Interrupt Control

| Bits | Description |
|------|-------------|
| 31:0 | Reserved.   |

#### D18F4x128 C-state Policy Control 1

Reset: 0080\_0000h.

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |      |             |     |                       |     |                |     |                |     |                |
|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|-----|-----------------------|-----|----------------|-----|----------------|-----|----------------|
| 31    | <b>CstateMsgDis: C-state messaging</b> disable. Read-write.<br>Specifies whether any messages are sent to the FCH when a core enters or exits a C-state. 0=Messages are sent. 1=Messages are not sent. See <a href="#">2.5.3.2.4.1 [FCH Messaging]</a> .                                                                                                                                                                                                                                                                  |      |             |     |                       |     |                |     |                |     |                |
| 30:25 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |      |             |     |                       |     |                |     |                |     |                |
| 24:23 | <b>CacheFlushSucMonMispredictAct: cache flush success monitor mispredict action</b> . Read-write.<br>BIOS: 01b.<br>Specifies the cache flush success monitor decrement when non-C0 residency is shorter than duration specified by CacheFlushSucMonTmrSel.<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>reset counter to zero</td></tr> <tr> <td>01b</td><td>decrement by 1</td></tr> <tr> <td>10b</td><td>decrement by 2</td></tr> <tr> <td>11b</td><td>decrement by 3</td></tr> </table> | Bits | Description | 00b | reset counter to zero | 01b | decrement by 1 | 10b | decrement by 2 | 11b | decrement by 3 |
| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |      |             |     |                       |     |                |     |                |     |                |
| 00b   | reset counter to zero                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |      |             |     |                       |     |                |     |                |     |                |
| 01b   | decrement by 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |      |             |     |                       |     |                |     |                |     |                |
| 10b   | decrement by 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |      |             |     |                       |     |                |     |                |     |                |
| 11b   | decrement by 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |      |             |     |                       |     |                |     |                |     |                |



| 22:21   | <b>CacheFlushSucMonTmrSel: cache flush success monitor timer select.</b> Read-write. BIOS: 00b.<br>Specifies the non-C0 duration used to increment the cache flush success monitor. <table> <tr> <th>Bits</th><th>Duration</th></tr> <tr> <td>00b</td><td>Use cache flush timer specified by <a href="#">D18F4x11[C:8]</a></td></tr> <tr> <td>01b</td><td><a href="#">D18F3xDC</a>[CacheFlushOnHaltTmr]</td></tr> <tr> <td>10b</td><td><a href="#">D18F4x128</a>[CacheFlushTmr]</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>                                                                                                                                                                                                                                        | Bits | Duration    | 00b | Use cache flush timer specified by <a href="#">D18F4x11[C:8]</a> | 01b     | <a href="#">D18F3xDC</a> [CacheFlushOnHaltTmr]                             | 10b | <a href="#">D18F4x128</a> [CacheFlushTmr] | 11b | Reserved |
|---------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|-----|------------------------------------------------------------------|---------|----------------------------------------------------------------------------|-----|-------------------------------------------|-----|----------|
| Bits    | Duration                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |      |             |     |                                                                  |         |                                                                            |     |                                           |     |          |
| 00b     | Use cache flush timer specified by <a href="#">D18F4x11[C:8]</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |      |             |     |                                                                  |         |                                                                            |     |                                           |     |          |
| 01b     | <a href="#">D18F3xDC</a> [CacheFlushOnHaltTmr]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |      |             |     |                                                                  |         |                                                                            |     |                                           |     |          |
| 10b     | <a href="#">D18F4x128</a> [CacheFlushTmr]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |      |             |     |                                                                  |         |                                                                            |     |                                           |     |          |
| 11b     | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |      |             |     |                                                                  |         |                                                                            |     |                                           |     |          |
| 20:18   | <b>CacheFlushSucMonThreshold: cache flush success monitor threshold.</b> Read-write. BIOS: 101b.<br>Flush the caches immediately if cache flushing is enabled and the cache flush success monitor count == CacheFlushSucMonThreshold. A value of 0 disables the cache flush success monitor. See <a href="#">D18F4x118/D18F4x11C</a> [CacheFlushEn].                                                                                                                                                                                                                                                                                                                                                                                                                              |      |             |     |                                                                  |         |                                                                            |     |                                           |     |          |
| 17:12   | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |      |             |     |                                                                  |         |                                                                            |     |                                           |     |          |
| 11:5    | <b>CacheFlushTmr: cache flush timer.</b> Read-write. BIOS: 32h.<br>Specifies how long each core needs to stay in a C-state before it flushes its caches. See <a href="#">D18F4x118/D18F4x11C</a> [CacheFlushTmrSel]. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00h</td><td>&lt;= 5.12 us</td></tr> <tr> <td>7Fh-01h</td><td>(&lt;CacheFlushTmr&gt; * 10.24us) - 5.12us &lt;= Time &lt;= &lt;CacheFlushTmr&gt; * 10.24 us</td></tr> </table>                                                                                                                                                                                                                                                                                                                    | Bits | Description | 00h | <= 5.12 us                                                       | 7Fh-01h | (<CacheFlushTmr> * 10.24us) - 5.12us <= Time <= <CacheFlushTmr> * 10.24 us |     |                                           |     |          |
| Bits    | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |      |             |     |                                                                  |         |                                                                            |     |                                           |     |          |
| 00h     | <= 5.12 us                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |      |             |     |                                                                  |         |                                                                            |     |                                           |     |          |
| 7Fh-01h | (<CacheFlushTmr> * 10.24us) - 5.12us <= Time <= <CacheFlushTmr> * 10.24 us                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |      |             |     |                                                                  |         |                                                                            |     |                                           |     |          |
| 4:2     | <b>HaltCstateIndex.</b> Read-write. BIOS: 0. Specifies the IO-based C-state that is invoked by a HLT instruction.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |      |             |     |                                                                  |         |                                                                            |     |                                           |     |          |
| 1       | <b>CoreCstatePolicy.</b> Read-write. BIOS: 0. Specifies how the processor arbitrates voltage and frequency when different non-C0 C-state requests are received on each core in a compute unit. 0=Transition both cores to the shallower C-state request. 1=Transition both cores to the deeper C-state request. For instance, if core 0 gets a request to go to C2 and core 1 gets a request to go to C1, hardware looks at the setting of CoreCstatePolicy. If CoreCstatePolicy is programmed to 0, the processor sends both cores to C1. If CoreCstatePolicy is programmed to 1, the processor sends both cores to C2. BIOS should program this field to the same value in all nodes of a multi-node processor. See also <a href="#">2.5.2.1 [Dependencies Between Cores]</a> . |      |             |     |                                                                  |         |                                                                            |     |                                           |     |          |
| 0       | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |      |             |     |                                                                  |         |                                                                            |     |                                           |     |          |

### D18F4x13C SMU P-state Control

Reset: 0000\_0000h. Read-only, updated-by-SMU.

| Bits | Description                                                                                                                                                                                                                                                                                                                            |
|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:4 | Reserved.                                                                                                                                                                                                                                                                                                                              |
| 3:1  | <b>SmuPstateLimit.</b> Specifies the highest-performance P-state (lowest value) allowed. SmuPstateLimit is always bounded by <a href="#">MSRC001_0061</a> [PstateMaxVal]. This field uses hardware P-state numbering. See <a href="#">MSRC001_0071</a> [CurPstateLimit] and <a href="#">2.5.3.1.1.2 [Hardware P-state Numbering]</a> . |
| 0    | <b>SmuPstateLimitEn.</b>                                                                                                                                                                                                                                                                                                               |

**D18F4x15C Core Performance Boost Control**

| Bits        | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |             |                    |     |                   |     |                  |     |          |     |          |
|-------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|--------------------|-----|-------------------|-----|------------------|-----|----------|-----|----------|
| 31          | <b>BoostLock.</b> Read-only. Reset: Product-specific. Specifies whether the following registers are Read-write, read-only, or have special requirements related to writability. See individual register definitions for details. <ul style="list-style-type: none"> <li>• <a href="#">MSRC001_00[6B:64]</a>[CpuFid, CpuDid, CpuVid].</li> <li>• <a href="#">D18F4x110</a>[MinResTmr]</li> <li>• <a href="#">D18F4x15C</a>[NumBoostStates].</li> <li>• <a href="#">D18F4x16C</a>[CstateCnt, CstateBoost].</li> <li>• <a href="#">D18F4x250</a>[NodeTdpLimit].</li> <li>• <a href="#">D18F5xEC</a>[LSCacThreshold, LSPstate, LSCpNum]</li> </ul> |             |                    |     |                   |     |                  |     |          |     |          |
| 30:9        | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |             |                    |     |                   |     |                  |     |          |     |          |
| 8           | <b>CstatePowerEn: C-state power enable.</b> If <a href="#">D18F2x1B4</a> [SmuCfgLock] THEN Read-only; updated-by-hardware. ELSE Read-write. ENDIF Reset: 0. BIOS: 1.                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |             |                    |     |                   |     |                  |     |          |     |          |
| 7           | <b>ApmMasterEn: APM master enable.</b> If <a href="#">D18F2x1B4</a> [SmuCfgLock] THEN Read-only; updated-by-hardware. ELSE Read-write. ENDIF Reset: 0.<br>BIOS: IF( <a href="#">D18F4x15C</a> [NumBoostStates]==0) THEN 0. ELSE 1. ENDIF.<br>1=Enables the ability to turn on features associated with APM when used in conjunction with the individual feature enable bits. See <a href="#">2.5.9 [Application Power Management (APM)]</a> .                                                                                                                                                                                                  |             |                    |     |                   |     |                  |     |          |     |          |
| 6:5         | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |             |                    |     |                   |     |                  |     |          |     |          |
| 4:2         | <b>NumBoostStates: number of boosted states.</b><br>IF ( <a href="#">D18F4x15C</a> [BoostLock]   ApmMasterEn   <a href="#">D18F2x1B4</a> [SmuCfgLock]) THEN Read-only. ELSE Read-write. ENDIF. Reset: Product-specific. Specifies the number of P-states that are considered boosted P-states. See <a href="#">2.5.9 [Application Power Management (APM)]</a> .                                                                                                                                                                                                                                                                                |             |                    |     |                   |     |                  |     |          |     |          |
| 1:0         | <b>BoostSrc: boost source.</b><br>If <a href="#">D18F2x1B4</a> [SmuCfgLock] THEN Read-only; updated-by-hardware. ELSE Read-write. ENDIF<br>Reset: 0.<br>BIOS: <a href="#">2.5.3.1.6</a> .<br>Specifies whether CPB is enabled or disabled. <table> <tr> <th><u>Bits</u></th><th><u>Description</u></th></tr> <tr> <td>00b</td><td>Boosting disabled</td></tr> <tr> <td>01b</td><td>Boosting enabled</td></tr> <tr> <td>10b</td><td>Reserved</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>                                                                                                                                         | <u>Bits</u> | <u>Description</u> | 00b | Boosting disabled | 01b | Boosting enabled | 10b | Reserved | 11b | Reserved |
| <u>Bits</u> | <u>Description</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |             |                    |     |                   |     |                  |     |          |     |          |
| 00b         | Boosting disabled                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |             |                    |     |                   |     |                  |     |          |     |          |
| 01b         | Boosting enabled                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |             |                    |     |                   |     |                  |     |          |     |          |
| 10b         | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |             |                    |     |                   |     |                  |     |          |     |          |
| 11b         | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |             |                    |     |                   |     |                  |     |          |     |          |

**D18F4x164 Fixed Errata**

| Bits | Description                                                                                                                                           |
|------|-------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:0 | <b>FixedErrata.</b> Value: Product-specific. See the Revision Guide for the definition of this field. See <a href="#">1.2 [Reference Documents]</a> . |

**D18F4x16C APM TDP Control**

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |     |             |    |                                                  |    |                                          |
|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-------------|----|--------------------------------------------------|----|------------------------------------------|
| 31:15 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |     |             |    |                                                  |    |                                          |
| 14    | <b>CacUpC1.</b> IF <a href="#">D18F4x15C</a> [BoostLock] THEN Read-only. ELSE Read-write. ENDIF.<br>Reset: Product-specific.<br>1=Cac interface is up on C1 (non XC6) state. 0=Cac interface is down and Cstate scalers are used in place of Cac reads.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |     |             |    |                                                  |    |                                          |
| 13    | <b>CstateCores.</b> IF <a href="#">D18F4x15C</a> [BoostLock] THEN Read-only. ELSE Read-write. ENDIF.<br>Reset: Product-specific.<br>Specifies how CstateCnt determines Cstate boost conditions.<br><table> <tr> <th>Bit</th><th>Description</th></tr> <tr> <td>0h</td><td>CstateCnt specifies the number of compute units.</td></tr> <tr> <td>1h</td><td>CstateCnt specifies the number of cores.</td></tr> </table>                                                                                                                                                                                                                                                                                                                                                                                       | Bit | Description | 0h | CstateCnt specifies the number of compute units. | 1h | CstateCnt specifies the number of cores. |
| Bit   | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |     |             |    |                                                  |    |                                          |
| 0h    | CstateCnt specifies the number of compute units.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |     |             |    |                                                  |    |                                          |
| 1h    | CstateCnt specifies the number of cores.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |     |             |    |                                                  |    |                                          |
| 12    | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |     |             |    |                                                  |    |                                          |
| 11:9  | <b>CstateCnt: C-state count.</b> IF <a href="#">D18F4x15C</a> [BoostLock] THEN Read-only. ELSE Read-write. ENDIF.<br>Reset: Product-specific. Specifies the number of cores or compute units (see CstateCores) that must be in CC6 before a transition can occur to a boosted P-state that is higher performance than the P-state specified by CstateBoost. A value of 0 disables access to P-states above CstateBoost.                                                                                                                                                                                                                                                                                                                                                                                    |     |             |    |                                                  |    |                                          |
| 8:6   | <b>CstateBoost.</b> Read-write. Reset: Product-specific. Specifies the P-state which requires the number of cores or compute units (see CstateCores) specified in CstateCnt to be in CC6 before a transition to a higher performance (lower numbered) boosted P-state is allowed. CstateBoost must be less than or equal to <a href="#">D18F4x15C</a> [NumBoostStates] otherwise undefined behavior results. If <a href="#">D18F4x15C</a> [BoostLock]=1, CstateBoost can only be written with values that are greater than or equal to the reset value. Attempts to write values less than the reset value are ignored. A value of 0 indicates that the C-state boost feature is not supported. This field uses hardware P-state numbering. See <a href="#">2.5.3.1.1.2 [Hardware P-state Numbering]</a> . |     |             |    |                                                  |    |                                          |
| 5     | <b>ApmTdpLimitSts: APM TDP limit status.</b> Read; set-by-hardware; write-1-to-clear. Reset: 0. This bit is set by hardware when <a href="#">D18F5xE8</a> [ApmTdpLimit] changes.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |     |             |    |                                                  |    |                                          |
| 4     | <b>ApmTdpLimitIntEn: APM TDP limit interrupt enable.</b> Read-write. Reset: 0. BIOS: 1. 1=Enables the generation of an interrupt using <a href="#">APIC330</a> of each core when <a href="#">D18F5xE8</a> [ApmTdpLimit] changes.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |     |             |    |                                                  |    |                                          |
| 3     | <b>TdpLimitDis.</b> IF <a href="#">D18F4x15C</a> [BoostLock] THEN Read-only. ELSE Read-write. ENDIF. Reset: 0. 1=Disables TDP limit checking and allows the processor to transition to higher performance P-states.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |     |             |    |                                                  |    |                                          |
| 2:0   | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |     |             |    |                                                  |    |                                          |

**D18F4x1C0 Node Cac Register 1**

| Bits  | Description                                                                                                                                                                                                            |
|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:12 | Reserved.                                                                                                                                                                                                              |
| 11:0  | <b>NodeCacLatest.</b> Read-only, updated-by-hardware. Reset: 0. Specifies the sum of all instantaneous power credits on each compute unit. NodeCacLatest is reset to 0 when <a href="#">D18F4x15C</a> [ApmMasterEn]=0. |

**D18F4x250 TDP Limit 8**

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31    | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 30:28 | <b>TdpLimitPstate</b> . Read-write. Reset: 0. Specifies the highest performance P-state that has a power consumption less than or equal to the TDP limit. This field is programmed by BIOS and uses software P-state numbering. See <a href="#">2.5.3.1.1.1 [Software P-state Numbering]</a> .                                                                                                                                                                                                                                                                                       |
| 27:12 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 11:0  | <b>NodeTdpLimit</b> . Read-write; <a href="#">Same-for-all</a> . Reset: Product-specific. Specifies the maximum allowed sum of TDPs from all cores on a node. If the consumed power exceeds the NodeTdpLimit, a P-state limit is applied to all cores on the processor to reduce the powerconsumption so that it remains within the TDP limit. If <a href="#">D18F4x15C[BoostLock]</a> =1, NodeTdpLimit can only be written with values that are less than or equal to the reset value. Attempts to write an invalid value are ignored. See <a href="#">2.5.9.2 [TDP Limiting]</a> . |

### 3.14 Device 18h Function 5 Configuration Registers

See 3.1 [Register Descriptions and Mnemonics]. See 2.7 [Configuration Space].

#### D18F5x00 Device/Vendor ID

| Bits  | Description                                          |
|-------|------------------------------------------------------|
| 31:16 | <b>DeviceID:</b> device ID. Read-only. Value: 141Fh. |
| 15:0  | <b>VendorID:</b> vendor ID. Read-only. Value: 1022h. |

#### D18F5x04 Status/Command

| Bits  | Description                              |
|-------|------------------------------------------|
| 31:16 | <b>Status.</b> Read-only. Value: 0000h.  |
| 15:0  | <b>Command.</b> Read-only. Value: 0000h. |

#### D18F5x08 Class Code/Revision ID

| Bits | Description                                                                                                           |
|------|-----------------------------------------------------------------------------------------------------------------------|
| 31:8 | <b>ClassCode.</b> Read-only. Value: 060000h. Provides the host bridge class code as defined in the PCI specification. |
| 7:0  | <b>RevID:</b> revision ID. Read-only. Value: 00h.                                                                     |

#### D18F5x0C Header Type

| Bits | Description                                                                                                                                                                                     |
|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:0 | <b>HeaderTypeReg.</b> Read-only. Reset: 0080_0000h. These bits are fixed at their default values. The header type field indicates that there are not multiple functions present in this device. |

#### D18F5x34 Capabilities Pointer

| Bits | Description                                                 |
|------|-------------------------------------------------------------|
| 31:8 | Reserved.                                                   |
| 7:0  | <b>CapPtr:</b> capabilities pointer. Read-only. Value: 00h. |

#### D18F5x[70,60,50,40] Northbridge Performance Event Select Low

| Bits | Description                                                                   |
|------|-------------------------------------------------------------------------------|
| 31:0 | <b>MSRC001_024[6,4,2,0][31:0]</b> is an alias of <b>D18F5x[70,60,50,40]</b> . |

**D18F5x[74,64,54,44] Northbridge Performance Event Select High**

| Bits | Description                                                                                      |
|------|--------------------------------------------------------------------------------------------------|
| 31:0 | <a href="#">MSRC001_024[6,4,2,0][63:32]</a> is an alias of <a href="#">D18F5x[74,64,54,44]</a> . |

**D18F5x[78,68,58,48] Northbridge Performance Event Counter Low**

| Bits | Description                                                                                     |
|------|-------------------------------------------------------------------------------------------------|
| 31:0 | <a href="#">MSRC001_024[7,5,3,1][31:0]</a> is an alias of <a href="#">D18F5x[78,68,58,48]</a> . |

**D18F5x[7C,6C,5C,4C] Northbridge Performance Event Counter High**

| Bits | Description                                                                                      |
|------|--------------------------------------------------------------------------------------------------|
| 31:0 | <a href="#">MSRC001_024[7,5,3,1][63:32]</a> is an alias of <a href="#">D18F5x[7C,6C,5C,4C]</a> . |

**D18F5x80 Compute Unit Status 1**

See [2.4.4 \[Processor Cores and Downcoring\]](#).

Software associates core ID to the cores of the compute units according to the following table. All combinations not listed are reserved.

**Table 187: D18F5x80[Enabled, DualCore] Definition**

| Enabled | DualCore | Definition                                                                |
|---------|----------|---------------------------------------------------------------------------|
| 1h      | 1h       | 1 compute unit is enabled; both cores of the compute unit are enabled.    |
| 3h      | 3h       | 2 compute units are enabled; both cores of each compute unit are enabled. |

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                      |     |             |     |                |     |                |       |          |
|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-------------|-----|----------------|-----|----------------|-------|----------|
| 31:24 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                        |     |             |     |                |     |                |       |          |
| 23:16 | <b>DualCore: both cores of a compute unit are enabled.</b> Read-only. Reset: Product-specific. 1=Both cores of a compute unit are enabled. See <a href="#">Table 187 [D18F5x80[Enabled, DualCore] Definition]</a> . <table> <tr> <th>Bit</th><th>Description</th></tr> <tr> <td>[0]</td><td>Compute unit 0</td></tr> <tr> <td>[1]</td><td>Compute unit 1</td></tr> <tr> <td>[7:2]</td><td>Reserved</td></tr> </table>            | Bit | Description | [0] | Compute unit 0 | [1] | Compute unit 1 | [7:2] | Reserved |
| Bit   | Description                                                                                                                                                                                                                                                                                                                                                                                                                      |     |             |     |                |     |                |       |          |
| [0]   | Compute unit 0                                                                                                                                                                                                                                                                                                                                                                                                                   |     |             |     |                |     |                |       |          |
| [1]   | Compute unit 1                                                                                                                                                                                                                                                                                                                                                                                                                   |     |             |     |                |     |                |       |          |
| [7:2] | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                         |     |             |     |                |     |                |       |          |
| 15:8  | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                        |     |             |     |                |     |                |       |          |
| 7:0   | <b>Enabled: at least one core of a compute unit is enabled.</b> Read-only. Reset: Product-specific. 1=At least one core is enabled in a compute unit. See <a href="#">Table 187 [D18F5x80[Enabled, DualCore] Definition]</a> . <table> <tr> <th>Bit</th><th>Description</th></tr> <tr> <td>[0]</td><td>Compute unit 0</td></tr> <tr> <td>[1]</td><td>Compute unit 1</td></tr> <tr> <td>[7:2]</td><td>Reserved</td></tr> </table> | Bit | Description | [0] | Compute unit 0 | [1] | Compute unit 1 | [7:2] | Reserved |
| Bit   | Description                                                                                                                                                                                                                                                                                                                                                                                                                      |     |             |     |                |     |                |       |          |
| [0]   | Compute unit 0                                                                                                                                                                                                                                                                                                                                                                                                                   |     |             |     |                |     |                |       |          |
| [1]   | Compute unit 1                                                                                                                                                                                                                                                                                                                                                                                                                   |     |             |     |                |     |                |       |          |
| [7:2] | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                         |     |             |     |                |     |                |       |          |

**D18F5x84 Northbridge Capabilities 2**

Unless otherwise specified, 1=The feature is supported by the processor; 0=The feature is not supported.

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                 |     |             |     |       |     |          |     |          |     |       |
|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-------------|-----|-------|-----|----------|-----|----------|-----|-------|
| 31:29 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                   |     |             |     |       |     |          |     |          |     |       |
| 28:24 | <b>DdrMaxRateEnf: enforced maximum DDR rate.</b> Read-only. Value: Product-specific. See: DdrMaxRate. Specifies the maximum DRAM data rate that the processor is designed to support. Writes to <a href="#">D18F2x94_dct[3:0][MemClkFreq]</a> that specify a frequency greater than specified by DdrMaxRateEnf will result in the <a href="#">D18F2x94_dct[3:0][MemClkFreq]</a> being set to DdrMaxRateEnf. |     |             |     |       |     |          |     |          |     |       |
| 23:21 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                   |     |             |     |       |     |          |     |          |     |       |
| 20:16 | <b>DdrMaxRate: maximum DDR rate.</b> Read-only. Value: Product-specific. Specifies the maximum DRAM data rate that the processor is designed to support. DdrMaxRate is defined by <a href="#">Table 141 [Valid Values for Memory Clock Frequency Value Definition]</a> ; except that 00h is defined as no limit. See <a href="#">D18F2x94_dct[3:0][MemClkFreq]</a> , and DdrMaxRateEnf.                     |     |             |     |       |     |          |     |          |     |       |
| 15:12 | <b>DctEn[3:0]: DCT[3:0] enabled.</b> Read-only. Value: Product-specific. Specifies which DCT controllers are enabled. 1=Enabled. 0=Disabled.<br><table> <tr> <th>Bit</th><th>Description</th></tr> <tr> <td>[0]</td><td>DCT 0</td></tr> <tr> <td>[1]</td><td>Reserved</td></tr> <tr> <td>[2]</td><td>Reserved</td></tr> <tr> <td>[3]</td><td>DCT 3</td></tr> </table>                                       | Bit | Description | [0] | DCT 0 | [1] | Reserved | [2] | Reserved | [3] | DCT 3 |
| Bit   | Description                                                                                                                                                                                                                                                                                                                                                                                                 |     |             |     |       |     |          |     |          |     |       |
| [0]   | DCT 0                                                                                                                                                                                                                                                                                                                                                                                                       |     |             |     |       |     |          |     |          |     |       |
| [1]   | Reserved                                                                                                                                                                                                                                                                                                                                                                                                    |     |             |     |       |     |          |     |          |     |       |
| [2]   | Reserved                                                                                                                                                                                                                                                                                                                                                                                                    |     |             |     |       |     |          |     |          |     |       |
| [3]   | DCT 3                                                                                                                                                                                                                                                                                                                                                                                                       |     |             |     |       |     |          |     |          |     |       |
| 11:8  | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                   |     |             |     |       |     |          |     |          |     |       |
| 7:0   | <b>CmpCap: CMP capable.</b> Read-only. Value: Product-specific. Number of cores on the node is CmpCap+1. CmpCap does not reflect cores disabled by <a href="#">D18F3x190[DisCore]</a> .                                                                                                                                                                                                                     |     |             |     |       |     |          |     |          |     |       |

**D18F5x88 NB Configuration 4 (NB\_CFG4)**

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                            |
|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:25 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                              |
| 24    | <b>DisHbNpReqBusLock.</b> Read-write. Reset: 0. BIOS: 1. 0=While bus locks are in progress, all non-posted commands from I/O, including atomics, are blocked until the core has completed the locked transaction and releases the bus. 1=All non-posted commands except atomics do not honor bus locks and are allowed to proceed. This bit may be set to achieve better DMA performance in the presence of bus locks. |
| 23:21 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                              |
| 20    | <b>DisSraCamXbarAddrMatch.</b> Read-write. Reset: 0. BIOS: 1. 1=Allow reads from ONION+ with SeqId=0 to be re-ordered by XCS.                                                                                                                                                                                                                                                                                          |
| 19    | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                              |
| 18    | <b>EnCstateBoostBlockCC6Exit.</b> Read-write. Reset: 0. BIOS: 1. 1=Cores cannot exit CC6 until VDD is less than or equal to the voltage of the P-state indexed by <a href="#">D18F4x16C[CstateBoost]</a> .                                                                                                                                                                                                             |
| 17:15 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                              |
| 14    | <b>DisHldRegRdRspChk.</b> Read-write. Reset: 0. BIOS: 1. 1=Disable primary holding register CPU or I/O read response checks.                                                                                                                                                                                                                                                                                           |

|      |           |
|------|-----------|
| 13:1 | Reserved. |
| 0    | Reserved. |

### D18F5x8C NB Configuration 5 (NB\_CFG5)

| Bits  | Description                                                                                                                    |
|-------|--------------------------------------------------------------------------------------------------------------------------------|
| 31:27 | Reserved.                                                                                                                      |
| 26    | <b>DisSrqPickNcReqThrtl.</b> Read-write. Reset: 1. 1=Disable throttling SRQ picker for requests sourced from the links.        |
| 25:16 | Reserved.                                                                                                                      |
| 15    | <b>EnSrqAllocGt31.</b> Read-write. Cold reset: 0b. BIOS: 1. 1=Enables allocation of SRA entries to above the lower 32 entries. |
| 14:2  | Reserved.                                                                                                                      |
| 1     | Reserved.                                                                                                                      |
| 0     | Reserved.                                                                                                                      |

### D18F5xE0 Processor TDP Running Average

| Bits | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:4 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| 3:0  | <b>RunAvgRange: running average range.</b> Read-write; <a href="#">Same-for-all</a> . Reset: 0. BIOS: 2h. Specifies the interval over which the processor averages power consumption estimates from the cores for boosting. Time interval = $2^{(\text{RunAvgRange} + 1)} \times \text{FreeRunSampleTimer}$ rate. A value of 0 disables the TDP running average accumulator capture function. See <a href="#">2.5.9 [Application Power Management (APM)]</a> . |

### D18F5xE8 TDP Limit 3

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                           |
|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:29 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                             |
| 28:16 | <b>ApmTdpLimit.</b> Read-only; updated-by-hardware. Value: <a href="#">D18F4x250[NodeTdpLimit]</a> . If the consumed node power exceeds the ApmTdpLimit on an single node processor or the ApmTdpLimit/2 on a multi-node processor, a P-state limit is applied to all cores on all nodes to reduce the power consumption to remain within the TDP limit. See <a href="#">2.5.9.2 [TDP Limiting]</a> . |
| 15:10 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                             |
| 9:0   | <b>Tdp2Watt.</b> Read-only. Value: Product-specific. Specifies in watts/TDP units the conversion factor for converting TDP units to watts. Tdp2Watt is a fixed point integer with 10 bits to the right of the decimal point and 0 bits to the left of the decimal point.                                                                                                                              |

### D18F5xEC Load Step Throttle Control

| Bits  | Description |
|-------|-------------|
| 31:19 | Reserved.   |



|      |                                                                                                                                                                                                                                                                                                                                                     |
|------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 18:7 | <b>LSCacThreshold: load step Cac threshold.</b> IF <a href="#">D18F4x15C</a> [BoostLock] THEN Read-only ELSE Read-write ENDIF. Cold reset: Product-specific. Specifies the power consumption threshold required for load step throttling. <a href="#">D18F4x1C0</a> [NodeCacLatest] must be less than LSCacThreshold prior to load step throttling. |
| 6:4  | <b>LSPstate: load step P-state.</b> Cold reset: Product-specific. IF <a href="#">D18F4x15C</a> [BoostLock] THEN Read-only ELSE Read-write ENDIF. Specifies the P-state threshold required for load step throttling. This field uses hardware P-state numbering. See <a href="#">2.5.3.1.1.2 [Hardware P-state Numbering]</a> .                      |
| 3:1  | <b>LSCpNum: load step compute unit number.</b> Cold reset: Product-specific. IF <a href="#">D18F4x15C</a> [BoostLock] THEN Read-only ELSE Read-write ENDIF. Specifies the compute unit threshold required for load step throttling. The number of compute units in C0 must be greater than LSCpNum prior to load step throttling. See LSPstate.     |
| 0    | <b>LSThrottleEn: load step throttle enable.</b> Cold reset: Product-specific. Read-write. 1=Enable the load step throttle controllers when the requirements in LSCpNum, LSPstate, and LSCacThreshold are met.                                                                                                                                       |

### D18F5x128 Clock Power/Timing Control 3

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |      |             |      |             |     |        |     |           |     |      |     |           |
|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|------|-------------|-----|--------|-----|-----------|-----|------|-----|-----------|
| 31    | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |      |             |      |             |     |        |     |           |     |      |     |           |
| 30    | <b>NbFidChgCpuOpEn.</b> Read-write. Cold reset: 0b. BIOS:1.                                                                                                                                                                                                                                                                                                                                                                                                                                 |      |             |      |             |     |        |     |           |     |      |     |           |
| 29:28 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |      |             |      |             |     |        |     |           |     |      |     |           |
| 27    | <b>SprSaveRestoreEn.</b> Read-write. Cold Reset:0. Enables SPR save/restore for non-retention NB power gating.                                                                                                                                                                                                                                                                                                                                                                              |      |             |      |             |     |        |     |           |     |      |     |           |
| 26:23 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |      |             |      |             |     |        |     |           |     |      |     |           |
| 22    | <b>NbPllPwrDwnRegEn: NB PLL power down.</b> Read-write. Cold reset: Product-specific. 1=The NB PLL is powered down when the NB is power gated and DRAM is placed into self-refresh (see <a href="#">2.5.4.2 [NB C-states]</a> ). 0=The NB PLL is not powered down during NB C-states.                                                                                                                                                                                                       |      |             |      |             |     |        |     |           |     |      |     |           |
| 21    | <b>PC6Vid[7].</b> Read-write. Cold reset: Product-specific. See PC6Vid[6:0].                                                                                                                                                                                                                                                                                                                                                                                                                |      |             |      |             |     |        |     |           |     |      |     |           |
| 20:18 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |      |             |      |             |     |        |     |           |     |      |     |           |
| 17    | <b>PwrGateDis: power-gate disable.</b> Read-write. Cold reset: 0. 1=NB power gating is disabled. 0=NB power gating is enabled. See <a href="#">2.5.4.2 [NB C-states]</a> .                                                                                                                                                                                                                                                                                                                  |      |             |      |             |     |        |     |           |     |      |     |           |
| 16    | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |      |             |      |             |     |        |     |           |     |      |     |           |
| 15    | <b>CC6PwrDwnRegEn: CC6 power down regulator enable.</b> Read-write. Cold reset: Product-specific. 1=Power down the VDDA regulator on CC6 entry. See PllRegTime.                                                                                                                                                                                                                                                                                                                             |      |             |      |             |     |        |     |           |     |      |     |           |
| 14    | <b>PC6PwrDwnRegEn: PC6 power down regulator enable.</b> Read-write. Cold reset: Product-specific. 1=Power down the VDDA regulator on PC6 entry. See PllRegTime.                                                                                                                                                                                                                                                                                                                             |      |             |      |             |     |        |     |           |     |      |     |           |
| 13:12 | <b>PwrGateTmr: power gate timer.</b> Read-write. Cold reset: 01b. BIOS: 01b. Specifies the minimum delay time required from the power gating or ungating of one Compute Unit to the power gating or ungating of the same Compute Unit or another Compute Unit. <table><tr><th>Bits</th><th>Description</th><th>Bits</th><th>Description</th></tr><tr><td>00b</td><td>500 ns</td><td>10b</td><td>Reserved.</td></tr><tr><td>01b</td><td>1 us</td><td>11b</td><td>Reserved.</td></tr></table> | Bits | Description | Bits | Description | 00b | 500 ns | 10b | Reserved. | 01b | 1 us | 11b | Reserved. |
| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Bits | Description |      |             |     |        |     |           |     |      |     |           |
| 00b   | 500 ns                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 10b  | Reserved.   |      |             |     |        |     |           |     |      |     |           |
| 01b   | 1 us                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 11b  | Reserved.   |      |             |     |        |     |           |     |      |     |           |

|             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |             |                    |             |                    |     |           |     |        |     |           |     |        |
|-------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|--------------------|-------------|--------------------|-----|-----------|-----|--------|-----|-----------|-----|--------|
| 11:10       | <b>PllVddOutUpTime.</b> Read-write. Cold reset: 0. The VDD regulator may be powered down when the processor transitions to PC6. If the regulator is powered down, this field specifies the time required to initialize the core PLL logic once the regulator is powered back up.<br><table><tr><td><u>Bits</u></td><td><u>Description</u></td><td><u>Bits</u></td><td><u>Description</u></td></tr><tr><td>00b</td><td>100 ns</td><td>10b</td><td>400 ns</td></tr><tr><td>01b</td><td>200 ns</td><td>11b</td><td>800 ns</td></tr></table>                                                                                                                                                                                                                                                                                                                                                                                                        | <u>Bits</u> | <u>Description</u> | <u>Bits</u> | <u>Description</u> | 00b | 100 ns    | 10b | 400 ns | 01b | 200 ns    | 11b | 800 ns |
| <u>Bits</u> | <u>Description</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <u>Bits</u> | <u>Description</u> |             |                    |     |           |     |        |     |           |     |        |
| 00b         | 100 ns                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 10b         | 400 ns             |             |                    |     |           |     |        |     |           |     |        |
| 01b         | 200 ns                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 11b         | 800 ns             |             |                    |     |           |     |        |     |           |     |        |
| 9           | <b>FastSlamTimeDown.</b> Read-write. Cold reset: 0. BIOS: 1. Specifies the time the processor waits for downward voltage transitions to complete. This field only effects transitions from <a href="#">D18F4x16C</a> [CstateBoost] or lower performance P-states. 0= <a href="#">D18F3xD8</a> [VSRampSlamTime] . 1=10 us.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |             |                    |             |                    |     |           |     |        |     |           |     |        |
| 8:7         | <b>PllRegTime: Pll regulator time.</b> Read-write. Cold reset: 10b. The VDDAregulator may be powered down when the processor transitions to PC6 or CC6. See PC6PwrDwnRegEn and CC6PwrDwnRegEn. If CC6PwrDwnRegEn=1, the VDDA regulator is powered down during CC6. If PC6PwrDwnRegEn=1, the VDDA regulator is powered down during PC6. If the VDDA regulator is powered down during CC6 and the core transitions from CC6 to PC6, the regulator remains powered down during PC6 regardless of the PC6PwrDwnRegEn setting. This field specifies the time required for the VDDA regulator to power back up and initialize the core PLL logic that is powered by the VDDA regulator.<br><table><tr><td><u>Bits</u></td><td><u>Description</u></td><td><u>Bits</u></td><td><u>Description</u></td></tr><tr><td>00b</td><td>Reserved.</td><td>10b</td><td>1.5 us</td></tr><tr><td>01b</td><td>Reserved.</td><td>11b</td><td>2.0 us</td></tr></table> | <u>Bits</u> | <u>Description</u> | <u>Bits</u> | <u>Description</u> | 00b | Reserved. | 10b | 1.5 us | 01b | Reserved. | 11b | 2.0 us |
| <u>Bits</u> | <u>Description</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <u>Bits</u> | <u>Description</u> |             |                    |     |           |     |        |     |           |     |        |
| 00b         | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 10b         | 1.5 us             |             |                    |     |           |     |        |     |           |     |        |
| 01b         | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 11b         | 2.0 us             |             |                    |     |           |     |        |     |           |     |        |
| 6:0         | <b>PC6Vid[6:0]: package C6 vid.</b> Read-write. Cold reset: Product-specific. PC6Vid[7:0] = {PC6Vid[7], PC6Vid[6:0]}. PC6Vid[7:0] specifies the VID driven in the PC6 state. See <a href="#">2.5.3.2.3.4 [Package C6 (PC6) State]</a> and <a href="#">2.5.1.3.2 [Low Power Voltages]</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |             |                    |             |                    |     |           |     |        |     |           |     |        |

#### D18F5x12C Clock Power/Timing Control 4

See the *AMD Serial VID Interface 2.0 (SVI2) Specification*.

| Bits | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31   | <p><b>Svi2CmdBusy.</b> Read-only; updated-by-hardware. Cold reset: 0. 1=SVI2 command in progress. This bit is set by hardware when any SVI2 command is sent to the voltage regulator. Software must wait for this bit to clear to 0 before writing any of the following fields: <a href="#">D18F5x12C</a>[CorePsi1En, CoreLoadLineTrim, CoreOffsetTrim], <a href="#">D18F5x188</a>[NbPsi1, NbLoadLineTrim, NbOffsetTrim], <a href="#">D18F5x18C</a>[CoreTfn, NbTfn]. This bit is cleared by hardware when the SVI2 command is complete. On a voltage change, this bit is cleared when the voltage transition is completed. See <a href="#">2.5.1.4.1 [Hardware-Initiated Voltage Transitions]</a>. On a telemetry or PSIx_L change, this bit is cleared as soon as the SVI2 command is sent to the voltage regulator. See <a href="#">2.5.1.1.1 [SVI2 Features]</a> and <a href="#">2.5.1.3.1 [PSIx_L Bit]</a>.</p> |
| 30   | <p><b>WaitVidCompDis: wait VID completion disable.</b> IF (<a href="#">D18F2x1B4</a>[SmuCfgLock]) THEN Read-only; updated-by-hardware. ELSE Read-write. ENDIF. Cold reset: 0. 0=Hardware waits for the VOTF complete indicator from the voltage regulator before clearing Svi2CmdBusy or making additional voltage change requests. 1=Hardware clears Svi2CmdBusy 500us after changes to CoreLoadLineTrim, CoreOffsetTrim, or <a href="#">D18F5x188</a>[NbLoadLineTrim, NbOffsetTrim] are made; hardware clears Svi2CmdBusy and additional voltage changes are allowed after the time specified by <a href="#">D18F3xD8</a>[VSRampSlamTime] . See <a href="#">2.5.1.4 [Voltage Transitions]</a>.</p>                                                                                                                                                                                                                |
| 29:6 | RAZ.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |

|             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |             |                    |             |                    |      |                           |      |      |      |       |      |       |      |      |      |      |      |    |      |      |
|-------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|--------------------|-------------|--------------------|------|---------------------------|------|------|------|-------|------|-------|------|------|------|------|------|----|------|------|
| 5           | <b>CorePsi1En: Core PSI1_L enable.</b> If <a href="#">D18F2x1B4</a> [SmuCfgLock] THEN Read-only; updated-by-hardware. ELSE Read-write. ENDIF Cold reset: 0. BIOS: 1. 0=PSI1_L for VDD is deasserted. 1=PSI1_L for VDD is asserted when all cores are in CC6. See <a href="#">2.5.3.2.3.4 [Package C6 (PC6) State]</a> , <a href="#">2.5.1.3.1 [PSIx_L Bit]</a> , and Svi2CmdBusy.                                                                                                                                                                                                                                                                                                                                                                                                         |             |                    |             |                    |      |                           |      |      |      |       |      |       |      |      |      |      |      |    |      |      |
| 4:2         | <b>CoreLoadLineTrim: Core load line trim.</b> IF ( <a href="#">D18F2x1B4</a> [SmuCfgLock]) THEN Read-only; updated-by-hardware. ELSE Read-write. ENDIF. Cold reset: 011b. BIOS: <a href="#">D0F0xBC_xC010_40A0</a> [SviLoadLineTrimVdd]. CoreLoadLineTrim and NbLoadLineTrim specify a percentage change relative to the initial load line slope for VDD and VDDNB, respectively. See Svi2CmdBusy. <table><tr><td><u>Bits</u></td><td><u>Description</u></td><td><u>Bits</u></td><td><u>Description</u></td></tr><tr><td>000b</td><td>Load line disabled</td><td>100b</td><td>+20%</td></tr><tr><td>001b</td><td>-40%</td><td>101b</td><td>+40%</td></tr><tr><td>010b</td><td>-20%</td><td>110b</td><td>+60%</td></tr><tr><td>011b</td><td>0%</td><td>111b</td><td>+80%</td></tr></table> | <u>Bits</u> | <u>Description</u> | <u>Bits</u> | <u>Description</u> | 000b | Load line disabled        | 100b | +20% | 001b | -40%  | 101b | +40%  | 010b | -20% | 110b | +60% | 011b | 0% | 111b | +80% |
| <u>Bits</u> | <u>Description</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <u>Bits</u> | <u>Description</u> |             |                    |      |                           |      |      |      |       |      |       |      |      |      |      |      |    |      |      |
| 000b        | Load line disabled                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 100b        | +20%               |             |                    |      |                           |      |      |      |       |      |       |      |      |      |      |      |    |      |      |
| 001b        | -40%                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 101b        | +40%               |             |                    |      |                           |      |      |      |       |      |       |      |      |      |      |      |    |      |      |
| 010b        | -20%                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 110b        | +60%               |             |                    |      |                           |      |      |      |       |      |       |      |      |      |      |      |    |      |      |
| 011b        | 0%                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 111b        | +80%               |             |                    |      |                           |      |      |      |       |      |       |      |      |      |      |      |    |      |      |
| 1:0         | <b>CoreOffsetTrim: Core offset trim.</b> IF ( <a href="#">D18F2x1B4</a> [SmuCfgLock]) THEN Read-only; updated-by-hardware. ELSE Read-write. ENDIF. Cold reset: 10b. BIOS: <a href="#">D0F0xBC_xC010_40A0</a> [SviLoadLineOffsetVdd]. CoreOffsetTrim and NbOffsetTrim specify a voltage offset relative to the initial load line offset for VDD and VDDNB, respectively. See Svi2CmdBusy. <table><tr><td><u>Bits</u></td><td><u>Description</u></td><td><u>Bits</u></td><td><u>Description</u></td></tr><tr><td>00b</td><td>Load line offset disabled</td><td>10b</td><td>0mV</td></tr><tr><td>01b</td><td>-25mV</td><td>11b</td><td>+25mV</td></tr></table>                                                                                                                               | <u>Bits</u> | <u>Description</u> | <u>Bits</u> | <u>Description</u> | 00b  | Load line offset disabled | 10b  | 0mV  | 01b  | -25mV | 11b  | +25mV |      |      |      |      |      |    |      |      |
| <u>Bits</u> | <u>Description</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <u>Bits</u> | <u>Description</u> |             |                    |      |                           |      |      |      |       |      |       |      |      |      |      |      |    |      |      |
| 00b         | Load line offset disabled                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 10b         | 0mV                |             |                    |      |                           |      |      |      |       |      |       |      |      |      |      |      |    |      |      |
| 01b         | -25mV                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 11b         | +25mV              |             |                    |      |                           |      |      |      |       |      |       |      |      |      |      |      |    |      |      |

### D18F5x16[C:0] Northbridge P-state [3:0]

Each of these registers specify the frequency and voltage associated with each of the NB P-states.

**Table 188: Register Mapping for D18F5x16[C:0]**

| Register  | Function     |
|-----------|--------------|
| D18F5x160 | NB P-state 0 |
| D18F5x164 | NB P-state 1 |
| D18F5x168 | NB P-state 2 |
| D18F5x16C | NB P-state 3 |

The NbVid field is allowed to be different between processors in a multi-processor system. All other fields are required to be programmed to the same value for all processors in the coherent fabric. See 2.5.4.1 [NB P-states] for more information about these registers.

**Table 189: NB P-state Definitions**

| Term            | Definition                                                                                                                         |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------|
| <b>NBCOF</b>    | NB current operating frequency in MHz. $NBCOF = 100 * (D18F5x16[C:0][NbFid] + 4h) / (2^{D18F5x16[C:0][NbDid]})$ .                  |
| <b>NBCOF[0]</b> | NB current operating frequency in MHz for NB P-state 0.<br>$NBCOF[0] = (100 * (D18F5x160[NbFid] + 4h) / (2^{D18F5x160[NbDid]}))$ . |

**Table 189: NB P-state Definitions**

| Term            | Definition                                                                                                                                                         |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>NBCOF[1]</b> | NB current operating frequency in MHz for NB P-state 1.<br>$\text{NBCOF}[1] = (100 * (\text{D18F5x164}[\text{NbFid}] + 4h) / (2^{\text{D18F5x164}[\text{NbDid}]})$ |
| <b>NBCOF[2]</b> | NB current operating frequency in MHz for NB P-state 2.<br>$\text{NBCOF}[2] = (100 * (\text{D18F5x168}[\text{NbFid}] + 4h) / (2^{\text{D18F5x168}[\text{NbDid}]})$ |
| <b>NBCOF[3]</b> | NB current operating frequency in MHz for NB P-state 3.<br>$\text{NBCOF}[3] = (100 * (\text{D18F5x16C}[\text{NbFid}] + 4h) / (2^{\text{D18F5x16C}[\text{NbDid}]})$ |

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |      |             |     |                                    |     |                                      |     |                                       |     |           |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|-----|------------------------------------|-----|--------------------------------------|-----|---------------------------------------|-----|-----------|
| 31:24 | <b>NbIddValue: northbridge current value.</b> Read-write. Cold reset: Product-specific. See NbIddDiv.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |      |             |     |                                    |     |                                      |     |                                       |     |           |
| 23:22 | <b>NbIddDiv: northbridge current divisor.</b> Read-write. Cold reset: Product-specific. After reset, NbIddDiv and NbIddValue combine to specify the expected maximum current drawn on the VDDNB power plane at a given VDDNB voltage. These values are intended to be used by <a href="#">2.5.1.3.1.1 [BIOS Requirements for PSIO_L]</a> . These values are not intended to convey final product power levels and may not match the power levels specified in the Power and Thermal Datasheet. These fields may be subsequently altered by software; they do not affect the hardware behavior.<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>IddValue / 1 A, Range: 0 to 255 A.</td></tr> <tr> <td>01b</td><td>IddValue / 10 A, Range: 0 to 25.5 A.</td></tr> <tr> <td>10b</td><td>IddValue / 100 A, Range: 0 to 2.55 A.</td></tr> <tr> <td>11b</td><td>Reserved.</td></tr> </table> | Bits | Description | 00b | IddValue / 1 A, Range: 0 to 255 A. | 01b | IddValue / 10 A, Range: 0 to 25.5 A. | 10b | IddValue / 100 A, Range: 0 to 2.55 A. | 11b | Reserved. |
| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |      |             |     |                                    |     |                                      |     |                                       |     |           |
| 00b   | IddValue / 1 A, Range: 0 to 255 A.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |      |             |     |                                    |     |                                      |     |                                       |     |           |
| 01b   | IddValue / 10 A, Range: 0 to 25.5 A.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |      |             |     |                                    |     |                                      |     |                                       |     |           |
| 10b   | IddValue / 100 A, Range: 0 to 2.55 A.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |      |             |     |                                    |     |                                      |     |                                       |     |           |
| 11b   | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |      |             |     |                                    |     |                                      |     |                                       |     |           |
| 21    | <b>NbVid[7].</b> Read-write. Cold reset: Product-specific. See NbVid[6:0].                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |      |             |     |                                    |     |                                      |     |                                       |     |           |
| 20    | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |      |             |     |                                    |     |                                      |     |                                       |     |           |
| 19    | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |      |             |     |                                    |     |                                      |     |                                       |     |           |
| 18    | <b>MemPstate: Memory P-state.</b> Read-write. Cold reset: Product-specific. 1=The Northbridge P-state specified by this register maps to memory P-state 1. 0=The Northbridge P-state specified by this register maps to memory P-state 0. Memory P-states may be globally disabled by programming <a href="#">D18F5x170[MemPstateDis]</a> . See <a href="#">2.5.7.1 [Memory P-states]</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |      |             |     |                                    |     |                                      |     |                                       |     |           |
| 17    | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |      |             |     |                                    |     |                                      |     |                                       |     |           |
| 16:10 | <b>NbVid[6:0]: Northbridge VID.</b> Read-write. Cold reset: Product-specific. $\text{NbVid}[7:0] = \{\text{NbVid}[7], \text{NbVid}[6:0]\}$ . NbVid[7:0] specifies the Northbridge voltage.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |      |             |     |                                    |     |                                      |     |                                       |     |           |
| 9:8   | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |      |             |     |                                    |     |                                      |     |                                       |     |           |
| 7     | <b>NbDid: Northbridge divisor ID.</b> Read-write. Cold reset: Product-specific. Specifies the Northbridge frequency divisor. See NbFid[5:0].                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |      |             |     |                                    |     |                                      |     |                                       |     |           |
| 6:1   | <b>NbFid[5:0]: Northbridge frequency ID.</b> Read-write. Cold reset: Product-specific. Specifies the Northbridge frequency multiplier. The NB COF is a function of NbFid and NbDid, and defined by <a href="#">NBCOF</a> . NbFid and NbDid are not changed on a write if the value written results in a frequency greater than <a href="#">MSRC001_0071[MaxNbCof]</a> . See <a href="#">2.5.3.1.5 [Core P-state Transition Behavior]</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |      |             |     |                                    |     |                                      |     |                                       |     |           |

|   |                                                                                                                                                                                                                                                                                                                                                                                              |
|---|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 0 | <b>NbPstateEn: Northbridge P-state enable.</b> Read-write. Cold reset: Product-specific. 1=The Northbridge P-state specified by this register is valid. 0=The Northbridge P-state specified by this register is not valid. This bit must be set to 1 in order for the Northbridge P-state specified by this register to be programmed in <a href="#">D18F5x170</a> [NbPstateHi, NbPstateLo]. |
|---|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

### D18F5x170 Northbridge P-state Control

See also [2.5.4.1 \[NB P-states\]](#).

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |      |             |      |             |      |     |      |     |      |      |      |     |      |       |      |      |      |       |      |      |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|------|-------------|------|-----|------|-----|------|------|------|-----|------|-------|------|------|------|-------|------|------|
| 31    | <b>MemPstateDis: memory P-state disable.</b> IF (D18F3xE8[MemPstateCap] && D18F2x1B4[SmuCfgLock]==0) THEN Read-write; updated-by-hardware; Updated-by-SMU. ELSE Read-only; updated-by-hardware; Updated-by-SMU. Reset: Product-specific. 1=Memory P-state transitions are disabled. The current P-state is not changed by programming this bit. The memory P-state will be forced to M0 on the next NB P-state transition. On processors where memory P-states are enabled, programming this bit may result in a violation of bandwidth requirements stated in 2.5.3.1.5 . Software must ensure that NB P-states which violate those requirements are forced disabled. 0=Memory P-state transitions are enabled if D18F2x90_dct[3:0][DisDllShutdownSR]=0. |      |             |      |             |      |     |      |     |      |      |      |     |      |       |      |      |      |       |      |      |
| 30    | <b>NbPstateFidVidSbcEn.</b> IF (D18F5x174[NbPstateDis]    D18F2x1B4[SmuCfgLock]) THEN Read-only. ELSE Read: Write-1-only. ENDIF. Reset: 0. BIOS: 1. NB P-state transitions are blocked until this field is set to a 1.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |      |             |      |             |      |     |      |     |      |      |      |     |      |       |      |      |      |       |      |      |
| 29:27 | <b>NbPstateHiRes: NB P-state high residency timer.</b> If D18F2x1B4[SmuCfgLock] THEN Read-only; updated-by-hardware. ELSE Read-write. ENDIF Reset: 0. Specifies the minimum time the processor must spend in the high NB P-state before transitions to the low NB P-state are allowed. See 2.5.4.1 [NB P-states]. <table><tr><th>Bits</th><th>Description</th><th>Bits</th><th>Description</th></tr><tr><td>000b</td><td>0us</td><td>100b</td><td>1ms</td></tr><tr><td>001b</td><td>10us</td><td>101b</td><td>5ms</td></tr><tr><td>010b</td><td>100us</td><td>110b</td><td>10ms</td></tr><tr><td>011b</td><td>500us</td><td>111b</td><td>50ms</td></tr></table>                                                                                           | Bits | Description | Bits | Description | 000b | 0us | 100b | 1ms | 001b | 10us | 101b | 5ms | 010b | 100us | 110b | 10ms | 011b | 500us | 111b | 50ms |
| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Bits | Description |      |             |      |     |      |     |      |      |      |     |      |       |      |      |      |       |      |      |
| 000b  | 0us                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 100b | 1ms         |      |             |      |     |      |     |      |      |      |     |      |       |      |      |      |       |      |      |
| 001b  | 10us                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 101b | 5ms         |      |             |      |     |      |     |      |      |      |     |      |       |      |      |      |       |      |      |
| 010b  | 100us                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 110b | 10ms        |      |             |      |     |      |     |      |      |      |     |      |       |      |      |      |       |      |      |
| 011b  | 500us                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 111b | 50ms        |      |             |      |     |      |     |      |      |      |     |      |       |      |      |      |       |      |      |
| 26:24 | <b>NbPstateLoRes: NB P-state low residency timer.</b> If D18F2x1B4[SmuCfgLock] THEN Read-only; updated-by-hardware. ELSE Read-write. ENDIF Reset: 0. Specifies the minimum time the processor must spend in the low NB P-state before transitions to the high NB P-state are allowed. See 2.5.4.1 [NB P-states]. See: NbPstateHiRes.                                                                                                                                                                                                                                                                                                                                                                                                                      |      |             |      |             |      |     |      |     |      |      |      |     |      |       |      |      |      |       |      |      |
| 23    | <b>NbPstateGnbSlowDis.</b> If D18F2x1B4[SmuCfgLock] THEN Read-only; updated-by-hardware. ELSE Read-write. ENDIF Reset: 0. Specifies whether NBP-state transitions take the GnbSlow signal into account. 0=Take GnbSlow into account. 1=Ignore GnbSlow. See 2.5.4.1 [NB P-states].                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |      |             |      |             |      |     |      |     |      |      |      |     |      |       |      |      |      |       |      |      |
| 22:15 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |      |             |      |             |      |     |      |     |      |      |      |     |      |       |      |      |      |       |      |      |
| 14    | <b>SwNbPstateLoDis: software NB P-state low disable.</b> IF (D18F5x174[NbPstateDis]   D18F2x1B4[SmuCfgLock]) THEN Read-only. ELSE Read-write. ENDIF. Reset: 0. 1=Transition to NbPstateHi and disable transitions to NbPstateLo.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |      |             |      |             |      |     |      |     |      |      |      |     |      |       |      |      |      |       |      |      |
| 13    | <b>NbPstateDisOnP0: NB P-state disable on P0.</b> IF (D18F5x174[NbPstateDis]   D18F2x1B4[SmuCfgLock]) THEN Read-only. ELSE Read-write. ENDIF. Reset: 0. 1=Transition to NbPstateHi and disable transitions to NbPstateLo if any compute unit is in P0 or a boosted P-state. This field uses software P-state numbering. See 2.5.3.1.1.1 [Software P-state Numbering].                                                                                                                                                                                                                                                                                                                                                                                     |      |             |      |             |      |     |      |     |      |      |      |     |      |       |      |      |      |       |      |      |

|      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 12:9 | <b>NbPstateThreshold: NB P-state threshold.</b> If <a href="#">D18F2x1B4</a> [SmuCfgLock] THEN Read-only; updated-by-hardware. ELSE Read-write. ENDIF Reset: Product-specific. BIOS: COUNT( <a href="#">D18F5x80</a> [Enabled]) . Specifies the minimum number of compute units that must be in a P-state with <a href="#">MSRC001_00</a> [6B:64][NbPstate]=1 before transitions to lower performance NB P-states are allowed. See NbPstateLo and NbPstateHi.                                                                                                                                                                                                                                                                                                                                                                                         |
| 8    | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| 7:6  | <b>NbPstateHi: NB P-state high.</b> IF ( <a href="#">D18F2x1B4</a> [SmuCfgLock]) THEN Read-only; updated-by-hardware. ELSE Read-write. ENDIF. Cold reset: Product-specific. If NB P-states are enabled, this field specifies the NB P-state that is used when the number of compute units in a P-state with <a href="#">MSRC001_00</a> [6B:64][NbPstate]=1 is less than NbPstateThreshold. This field must be programmed to the same value for all processors in the coherent fabric. This field is not changed on a write if the value written is greater than the NbPstateMaxVal value written or greater than the current NbPstateLo value. See also NbPstateDisOnP0, SwNbPstateLoDis, NbPstateLo, <a href="#">D18F5x174</a> [NbPstateDis], and <a href="#">D18F5x16</a> [C:0][NbPstateEn].                                                        |
| 5    | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| 4:3  | <b>NbPstateLo: NB P-state low.</b> IF ( <a href="#">D18F2x1B4</a> [SmuCfgLock]) THEN Read-only; updated-by-hardware. ELSE Read-write. ENDIF. Cold reset: Product-specific. If NB P-states are enabled, this field specifies the NB P-state that is used when the number of compute units in a P-state with <a href="#">MSRC001_00</a> [6B:64][NbPstate]=1 is greater than or equal to NbPstateThreshold. NbPstateLo must be greater than or equal to NbPstateHi. This field must be programmed to the same value for all processors in the coherent fabric. This field is not changed on a write if the value written is greater than the NbPstateMaxVal value written or less than the current NbPstateHi value. See also NbPstateDisOnP0, SwNbPstateLoDis, <a href="#">D18F5x174</a> [NbPstateDis], and <a href="#">D18F5x16</a> [C:0][NbPstateEn]. |
| 2    | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| 1:0  | <b>NbPstateMaxVal: NB P-state maximum value.</b> IF ( <a href="#">D18F2x1B4</a> [SmuCfgLock]) THEN Read-only; updated-by-hardware. ELSE Read-write. ENDIF. Cold reset: specified by the reset state of <a href="#">D18F5x16</a> [C:0][NbPstateEn]; the cold reset value is the highest NB P-state number corresponding to the register in which NbPstateEn is set (e.g., if <a href="#">D18F5x160</a> and <a href="#">D18F5x164</a> have this bit set and the others do not, then NbPstateMaxVal=1; if NbPstateEn is only set in <a href="#">D18F5x160</a> , then NbPstateMaxVal=0). This specifies the highest NB P-state value (lowest performance state) supported by the hardware.                                                                                                                                                                |

### D18F5x174 Northbridge P-state Status

| Bits  | Description                                                                                                                                                                                                          |
|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:25 | Reserved.                                                                                                                                                                                                            |
| 24    | <b>CurMemPstate: current memory P-state.</b> Read-only; updated-by-hardware. Reset: 0. Specifies the current memory P-state. 1=Memory P-state 1. 0=Memory P-state 0. See <a href="#">2.5.7.1 [Memory P-states]</a> . |
| 23    | <b>CurNbVid[7]: current northbridge voltage ID[7].</b> <a href="#">MSRC001_0071</a> [CurNbVid[7]] is an alias of <a href="#">D18F5x174</a> [CurNbVid[7]]. . VDDNB voltage.                                           |
| 22    | <b>CurNbPstateLo.</b> Read-only; updated-by-hardware. Reset: 0. 1=Current NB Pstate maps to <a href="#">D18F5x170</a> [NbPstateLo]. 0=Current NB Pstate maps to <a href="#">D18F5x170</a> [NbPstateHi].              |
| 21    | Reserved.                                                                                                                                                                                                            |



| 20:19 | <b>CurNbPstate: current northbridge P-state.</b> Read-only; updated-by-hardware. Reset: 0. Provides the NB P-state that corresponds to the current frequency component of the NB. The value of this field is updated when the COF transitions to a new value associated with an NB P-state.<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>NB P0</td></tr> <tr> <td>01b</td><td>NB P1</td></tr> <tr> <td>10b</td><td>NB P2</td></tr> <tr> <td>11b</td><td>NB P3</td></tr> </table> | Bits | Description | 00b | NB P0 | 01b | NB P1 | 10b | NB P2 | 11b | NB P3 |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|-----|-------|-----|-------|-----|-------|-----|-------|
| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |      |             |     |       |     |       |     |       |     |       |
| 00b   | NB P0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |      |             |     |       |     |       |     |       |     |       |
| 01b   | NB P1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |      |             |     |       |     |       |     |       |     |       |
| 10b   | NB P2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |      |             |     |       |     |       |     |       |     |       |
| 11b   | NB P3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |      |             |     |       |     |       |     |       |     |       |
| 18:12 | <b>CurNbVid[6:0]: current northbridge voltage ID.</b> <a href="#">MSRC001_0071</a> [CurNbVid[6:0]] is an alias of <a href="#">D18F5x174</a> [CurNbVid[6:0]]. VDDNB voltage.                                                                                                                                                                                                                                                                                                                                     |      |             |     |       |     |       |     |       |     |       |
| 11    | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |      |             |     |       |     |       |     |       |     |       |
| 10    | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |      |             |     |       |     |       |     |       |     |       |
| 9     | <b>CurNbDid: current northbridge divisor ID.</b> Read-only; updated-by-hardware. Reset: 0.                                                                                                                                                                                                                                                                                                                                                                                                                      |      |             |     |       |     |       |     |       |     |       |
| 8:3   | <b>CurNbFid[5:0]: current northbridge frequency ID.</b> Read-only; updated-by-hardware. Reset: 0.                                                                                                                                                                                                                                                                                                                                                                                                               |      |             |     |       |     |       |     |       |     |       |
| 2:1   | <b>StartupNbPstate: startup northbridge P-state number.</b> Read-only. Cold reset: Product-specific. Specifies the cold reset VID, FID and DID for the Northbridge based on the NB P-state number selected.                                                                                                                                                                                                                                                                                                     |      |             |     |       |     |       |     |       |     |       |
| 0     | <b>NbPstateDis: northbridge P-state disable.</b> Read-only. Value: Product-specific. <a href="#">MSRC001_0071</a> [NbPstateDis] is an alias of <a href="#">D18F5x174</a> [NbPstateDis].                                                                                                                                                                                                                                                                                                                         |      |             |     |       |     |       |     |       |     |       |

### D18F5x178 Northbridge Fusion Configuration

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                           |
|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:20 | Reserved.                                                                                                                                                                                                                                                                                                                                                                             |
| 19    | <b>SwGfxDis.</b> Read-write. Reset: 1. BIOS: IF ( <a href="#">GpuEnabled</a> ) THEN 0 ELSE 1 ENDIF. 1=Hardware handshakes for NB P-state transitions and DRAM self-refresh entry are ignored. See <a href="#">2.5.4.1.2 [NB P-state Transitions]</a> . See <a href="#">2.5.7.2 [DRAM Self-Refresh]</a> .                                                                              |
| 18    | <b>CstateFusionHsDis: C-state fusion handshake disable.</b> Read-write. Reset: 0. BIOS: 1. 1=Ignore the FCH handshake response for PC6 transitions. 0=Use the FCH handshake response for PC6 entry. See <a href="#">2.5.3.2.4.1 [FCH Messaging]</a> .                                                                                                                                 |
| 17    | <b>Dis2ndGnbAllowPsWait.</b> Read-write. Reset: 0. BIOS: 1. 1=Do not do a second check of AllowNb-Trans after quiescing the cores when transitioning NB P-states. See <a href="#">2.5.4.1.2 [NB P-state Transitions]</a> .                                                                                                                                                            |
| 16    | <b>ProcHotToGnbEn.</b> Read-write. Reset: 0. BIOS: 1. 1=The GPU is placed into a low-power state when PROCHOT_L is asserted. Note: the GPU power-state transitions associated with PROCHOT_L nominally occur every 1 millisecond; PROCHOT_L assertions and deassertions for less than this period may not result in GPU state changes.                                                |
| 15:12 | Reserved.                                                                                                                                                                                                                                                                                                                                                                             |
| 11    | <b>AllowSelfRefrS3Dis: allow self-refresh S3 disable.</b> Read-write. Reset: 0. BIOS: 1. 1=The NB does not wait for handshake before placing DRAM into self-refresh (see <a href="#">2.5.7.2 [DRAM Self-Refresh]</a> ) on S3 entry (see <a href="#">2.5.8.1.1 [ACPI Suspend to RAM State (S3)]</a> ). 0=The NB waits for handshake before placing DRAM into self-refresh on S3 entry. |

|     |                                                                                                                                                                                                                                                                                                                                                                       |
|-----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 10  | <b>InbWakeS3Dis: InbWake S3 disable.</b> Read-write. Reset: 0. BIOS: 1. 1= The NB does not wait for handshake before placing DRAM into self-refresh (see <a href="#">2.5.7.2 [DRAM Self-Refresh]</a> ) on S3 entry (see <a href="#">2.5.8.1.1 [ACPI Suspend to RAM State (S3)]</a> ). 0=The NB waits for handshake before placing DRAM into self-refresh on S3 entry. |
| 9:4 | Reserved.                                                                                                                                                                                                                                                                                                                                                             |
| 3   | <b>CstateThreeWayHsEn: C-state three way handshake disable.</b> Read-write. Reset: 0. 1=Enable the three way handshake with the FCH when entering a C-state. 0=Only a two way handshake with FCH is used. There is no message about the resulting package state sent to FCH. See <a href="#">2.5.3.2.4.1 [FCH Messaging]</a> .                                        |
| 2   | <b>CstateFusionDis: C-state fusion disable.</b> Read-write. Reset: 0. 1=All HALT or C-state requests are forwarded to the FCH. 0=HALT and C-state requests are forwarded to the FCH when each core has made a request. See <a href="#">2.5.3.2.4.1 [FCH Messaging]</a> .                                                                                              |
| 1:0 | Reserved.                                                                                                                                                                                                                                                                                                                                                             |

### D18F5x17C Miscellaneous Voltages

| Bits  | Description                                                                                                                                                                                                                                                                                                                            |
|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31    | <b>NbPsi0VidEn: Northbridge PSI0_L VID enable.</b> Read-write. Reset: 0. This bit specifies how PSI0_L is controlled for VDDNB. See <a href="#">D18F3xA0[PsiVidEn]</a> and <a href="#">2.5.1.3.1 [PSIx_L Bit]</a> .                                                                                                                    |
| 30:23 | <b>NbPsi0Vid[7:0]: Northbridge PSI0_L VID threshold.</b> Read-write. Reset: 0. When enabled by NbPsi0VidEn, NbPsi0Vid specifies the threshold value of the VID code generated by the Northbridge, which in turn determines the state of PSI0_L. See <a href="#">D18F3xA0[PsiVid[6:0]]</a> and <a href="#">2.5.1.3.1 [PSIx_L Bit]</a> . |
| 22:18 | Reserved.                                                                                                                                                                                                                                                                                                                              |
| 17:10 | <b>MinVid: minimum voltage.</b> Read-only. Reset: Product-specific. Specifies the VID code corresponding to the minimum voltage (highest VID code) that the processor drives. 00h indicates that no minimum VID code is specified. See <a href="#">2.5.1 [Processor Power Planes And Voltage Control]</a> .                            |
| 9:8   | Reserved.                                                                                                                                                                                                                                                                                                                              |
| 7:0   | <b>MaxVid: maximum voltage.</b> Read-only. Reset: Product-specific. Specifies the VID code corresponding to the maximum voltage (lowest VID code) that the processor drives. 00h indicates that no maximum VID code is specified. See <a href="#">2.5.1 [Processor Power Planes And Voltage Control]</a> .                             |

### D18F5x188 Clock Power/Timing Control 5

See the *AMD Serial VID Interface 2.0 (SVI2) Specification*.

| Bits | Description                                                                                                                                                                                                                                                                                  |
|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:6 | RAZ.                                                                                                                                                                                                                                                                                         |
| 5    | <b>NbPsi1: Northbridge PSI1_L.</b> IF <a href="#">D18F2x1B4[SmuCfgLock]</a> THEN Read-only; updated-by-hardware. ELSE Read-write. ENDIF Cold reset: 0. Specifies how PSI1_L is controlled for VDDNB. 1=PSI1_L is low. 0=PSI1_L is high. See <a href="#">2.5.1.3.1 [PSIx_L Bit]</a> .         |
| 4:2  | <b>NbLoadLineTrim: Northbridge load line trim.</b> IF <a href="#">D18F2x1B4[SmuCfgLock]</a> THEN Read-only; updated-by-hardware. ELSE Read-write. ENDIF Cold reset: 011b. BIOS: <a href="#">D0F0xBC_xC010_40A0[SviLoadLineTrimVddNb]</a> . See <a href="#">D18F5x12C[CoreLoadLineTrim]</a> . |



|     |                                                                                                                                                                                                                                                                                           |
|-----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1:0 | <b>NbOffsetTrim: Northbridge offset trim.</b> IF <a href="#">D18F2x1B4</a> [SmuCfgLock] THEN Read-only; updated-by-hardware. ELSE Read-write. ENDIF. Cold reset: 10b. BIOS: <a href="#">D0F0xBC_xC010_40A0</a> [SviLoad-LineOffsetVddNb]. See <a href="#">D18F5x12C</a> [CoreOffsetTrim]. |
|-----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

### D18F5x18C Clock Power/Timing Control 6

See the *AMD Serial VID Interface 2.0 (SVI2) Specification*.

| Bits           | Description                                                                                                                                                                                                                                                                       |
|----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:2           | RAZ.                                                                                                                                                                                                                                                                              |
| 1              | <b>CoreTfn: Core telemetry functionality.</b> If <a href="#">D18F2x1B4</a> [SmuCfgLock] THEN Read-only; updated-by-hardware. ELSE Read-write. ENDIF Cold reset: 0. BIOS: 1. See NbTfn.                                                                                            |
| 0              | <b>NbTfn: Northbridge telemetry functionality.</b> If <a href="#">D18F2x1B4</a> [SmuCfgLock] THEN Read-only; updated-by-hardware. ELSE Read-write. ENDIF. Cold reset: 0. See <a href="#">D18F5x12C</a> [Svi2CmdBusy].<br>CoreTfn and NbTfn specify the telemetry mode as follows: |
| <u>CoreTfn</u> | <u>NbTfn</u> <u>Description</u>                                                                                                                                                                                                                                                   |
| 0              | 0      Telemetry enabled in voltage-only mode.                                                                                                                                                                                                                                    |
| 0              | 1      Telemetry enabled in voltage and current mode.                                                                                                                                                                                                                             |
| 1              | 0      Telemetry disabled.                                                                                                                                                                                                                                                        |
| 1              | 1      Reserved.                                                                                                                                                                                                                                                                  |

### D18F5x194 Name String Address Port

[D18F5x194](#) and [D18F5x198](#) provide BIOS with a read-only name string that may be copied to [MSRC001\\_00](#)[35:30] at warm reset. Each of [D18F5x198\\_x](#)[B:0] is read as follows:

1. Write [D18F5x194](#)[Index].
2. Read [D18F5x198](#).

| Bits        | Description                                                                      |
|-------------|----------------------------------------------------------------------------------|
| 31:4        | Reserved.                                                                        |
| 3:0         | <b>Index: name string register index.</b> Read-write. <u>Reset: 0.</u> Reset: 0. |
| <u>Bits</u> | <u>Description</u>                                                               |
| Bh-0h       | Name String Registers. See <a href="#">D18F5x198_x</a> [B:0].                    |
| Fh-Ch       | Reserved                                                                         |

### D18F5x198 Name String Data Port

See [D18F5x194](#) for register access information. Address: [D18F5x194](#)[Index].

| Bits | Description                   |
|------|-------------------------------|
| 31:0 | <b>Data.</b> <u>Reset: 0.</u> |

### D18F5x198\_x[B:0] Name String Data

| Bits  | Description                                                                                |
|-------|--------------------------------------------------------------------------------------------|
| 31:24 | <b>NameStringByte3: name string ASCII character 3.</b> Read-only. Value: Product-specific. |
| 23:16 | <b>NameStringByte2: name string ASCII character 2.</b> Read-only. Value: Product-specific. |

|      |                                                                                            |
|------|--------------------------------------------------------------------------------------------|
| 15:8 | <b>NameStringByte1: name string ASCII character 1.</b> Read-only. Value: Product-specific. |
| 7:0  | <b>NameStringByte0: name string ASCII character 0.</b> Read-only. Value: Product-specific. |

### D18F5x240 ECC Exclusion Base Address Low

- Transaction addresses are within the defined range if:  
EccExclBaseAddr[47:6] <= address[47:6] <= EccExclLimitAddr[47:6].
- BIOS must quiesce all other forms of DRAM traffic when configuring this range. See [MSRC001\\_001F](#)[Dis-DramScrub].
- When initializing the base/limit pair, the BIOS must write the limit register before the EccExclEn bit is set. BIOS should clear EccExclEn before changing the address range.
- BIOS should take care to re-initialize memory with valid ECC when resizing this region.

| Bits | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:6 | <b>EccExclBaseAddr[31:6]: ECC exclusion base address register bits[31:6].</b> Read-write. Reset: 0. EccExclBaseAddr[47:6]={ <a href="#">D18F5x244</a> [EccExclBaseAddr[47:32]], EccExclBaseAddr[31:6]}. The ECC Exclusion Base/Limit Address registers setup a contiguous range in DRAM where ECC check and error reporting is disabled. BIOS configures the ECC exclusion range code to cover the frame buffer region in ECC UMA systems with internal GPUs. The GPU is configured as MC_SHARED:MC_VM_STEERING [DEFAULT_STEERING]=1 (system traffic to onion). |
| 5:1  | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 0    | <b>EccExclEn.</b> Read-write. Reset: 0. 1=Enable ECC Exclusion Range. See <a href="#">D18F5x240</a> [EccExclBase-Addr].                                                                                                                                                                                                                                                                                                                                                                                                                                         |

### D18F5x244 ECC Exclusion Base Address High

| Bits  | Description                                                                                                                                            |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:16 | Reserved.                                                                                                                                              |
| 15:0  | <b>EccExclBaseAddr[47:32]: ECC exclusion base address register bits[47:32].</b> Read-write. Reset: 0. See <a href="#">D18F5x240</a> [EccExclBaseAddr]. |

### D18F5x248 ECC Exclusion Limit Address Low

| Bits | Description                                                                                                                                                                                                                                                   |
|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:6 | <b>EccExclLimitAddr[31:6]: ECC exclusion limit address register bits[31:6].</b> Read-write. Reset: 0. EccExclLimitAddr[47:6]={ <a href="#">D18F5x24C</a> [EccExclLimitAddr[47:32]], EccExclLimitAddr[31:6]}. See <a href="#">D18F5x240</a> [EccExclBaseAddr]. |
| 5:0  | Reserved.                                                                                                                                                                                                                                                     |

### D18F5x24C ECC Exclusion Limit Address High

| Bits | Description |
|------|-------------|
|------|-------------|

|       |                                                                                                                                                          |
|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:16 | Reserved.                                                                                                                                                |
| 15:0  | <b>EccExclLimitAddr[47:32]: ECC exclusion limit address register bits[47:32].</b> Read-write. Reset: 0. See <a href="#">D18F5x240</a> [EccExclBaseAddr]. |

### D18F5x260 Clock Power/Timing Control 8

| Bits        | Description                                                                                                                                                                                                                                                                                                                                                              |             |                    |      |    |      |    |      |    |           |           |
|-------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|--------------------|------|----|------|----|------|----|-----------|-----------|
| 31:4        | Reserved.                                                                                                                                                                                                                                                                                                                                                                |             |                    |      |    |      |    |      |    |           |           |
| 3:1         | <b>ClkStretchPercent: clock stretch percent.</b> Read-only. Reset: Product-specific. Specifies the percentage of clock stretching.<br><table> <tr> <th><u>Bits</u></th><th><u>Description</u></th></tr> <tr> <td>000b</td><td>0%</td></tr> <tr> <td>001b</td><td>5%</td></tr> <tr> <td>010b</td><td>7%</td></tr> <tr> <td>111b-011b</td><td>Reserved.</td></tr> </table> | <u>Bits</u> | <u>Description</u> | 000b | 0% | 001b | 5% | 010b | 7% | 111b-011b | Reserved. |
| <u>Bits</u> | <u>Description</u>                                                                                                                                                                                                                                                                                                                                                       |             |                    |      |    |      |    |      |    |           |           |
| 000b        | 0%                                                                                                                                                                                                                                                                                                                                                                       |             |                    |      |    |      |    |      |    |           |           |
| 001b        | 5%                                                                                                                                                                                                                                                                                                                                                                       |             |                    |      |    |      |    |      |    |           |           |
| 010b        | 7%                                                                                                                                                                                                                                                                                                                                                                       |             |                    |      |    |      |    |      |    |           |           |
| 111b-011b   | Reserved.                                                                                                                                                                                                                                                                                                                                                                |             |                    |      |    |      |    |      |    |           |           |
| 0           | <b>ClkStretchEn: clock stretch enable.</b> Read-only. Reset: Product-specific. 1=Clock stretch enable. 0=Clock stretch disable.                                                                                                                                                                                                                                          |             |                    |      |    |      |    |      |    |           |           |

### 3.15 Northbridge IOAPIC Registers

The Northbridge IOAPIC is accessed through the Northbridge IOAPIC base address specified by [D0F0xFC\\_x01 \[IOAPIC Base Address Lower\]](#) and [D0F0xFC\\_x02 \[IOAPIC Base Address Upper\]](#).

#### NBIOAPICx00 IO Register Select

| Bits | Description                                                                                                                                |
|------|--------------------------------------------------------------------------------------------------------------------------------------------|
| 31:8 | Reserved.                                                                                                                                  |
| 7:0  | <b>IndirectAddressOffset</b> . Read-write. Reset: 0. Specifies the indexed register accessed via <a href="#">NBIOAPICx10 [IO Window]</a> . |

#### NBIOAPICx10 IO Window

| Bits | Description         |
|------|---------------------|
| 31:0 | <b>IoapicData</b> . |

#### NBIOAPICx10\_x00 IOAPIC ID

This register is not used in IOxAPIC PCI bus delivery mode.

| Bits  | Description                                                                                                                                         |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:28 | <b>ExtendID: extended IOAPIC device ID</b> . IF ( <a href="#">D0F0xFC_x00</a> [IoapicIdExtEn]==0) THEN Read-only. ELSE Read-write. ENDIF. Reset: 0. |
| 27:24 | <b>ID: IOAPIC device ID</b> . Read-write. Reset: 0.                                                                                                 |
| 23:0  | Reserved.                                                                                                                                           |

#### NBIOAPICx10\_x01 IOAPIC Version

| Bits  | Description                                                             |
|-------|-------------------------------------------------------------------------|
| 31:24 | Reserved.                                                               |
| 23:16 | <b>MaxRedirectionEntries</b> . Value: 1Fh. Indicates 32 entries [31:0]. |
| 15    | <b>PRQ</b> . Value: 1. IRQ pin assertion supported                      |
| 14:8  | Reserved.                                                               |
| 7:0   | <b>Version</b> . Value: 21h. PCI 2.2 compliant                          |

#### NBIOAPICx10\_x02 IOAPIC Arbitration

| Bits  | Description                                 |
|-------|---------------------------------------------|
| 31:28 | Reserved.                                   |
| 27:24 | <b>ArbitrationID</b> . Read-only. Reset: 0. |
| 23:0  | Reserved.                                   |

**NBIOAPICx10\_x[4E:10:step2] Redirection Table Entry [31:0]**

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                     |      |            |      |            |      |       |      |     |      |                 |      |      |      |         |      |          |      |          |      |        |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------------|------|------------|------|-------|------|-----|------|-----------------|------|------|------|---------|------|----------|------|----------|------|--------|
| 63:56 | <b>DestinationID.</b> Read-write. Reset: 0. Bits [19:12] of the address field of the interrupt message.                                                                                                                                                                                                                                                                                                         |      |            |      |            |      |       |      |     |      |                 |      |      |      |         |      |          |      |          |      |        |
| 55:32 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                       |      |            |      |            |      |       |      |     |      |                 |      |      |      |         |      |          |      |          |      |        |
| 31:17 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                       |      |            |      |            |      |       |      |     |      |                 |      |      |      |         |      |          |      |          |      |        |
| 16    | <b>Mask.</b> Read-write. Reset: 1. 1=Mask the interrupt injection at the input of this device. 0=Unmask.                                                                                                                                                                                                                                                                                                        |      |            |      |            |      |       |      |     |      |                 |      |      |      |         |      |          |      |          |      |        |
| 15    | <b>TriggerMode.</b> Read-write. Reset: 0. 0=Edge. 1=Level                                                                                                                                                                                                                                                                                                                                                       |      |            |      |            |      |       |      |     |      |                 |      |      |      |         |      |          |      |          |      |        |
| 14    | <b>RemotelIRR.</b> Read-only. Reset: 0. Used for level triggered interrupts only. It is cleared by EOI special cycle transaction or write to EOI register. 1=Interrupt message is delivered.                                                                                                                                                                                                                    |      |            |      |            |      |       |      |     |      |                 |      |      |      |         |      |          |      |          |      |        |
| 13    | <b>InterruptPinPolarity.</b> Read-write. Reset: 0. 0=High. 1=Low.                                                                                                                                                                                                                                                                                                                                               |      |            |      |            |      |       |      |     |      |                 |      |      |      |         |      |          |      |          |      |        |
| 12    | <b>DeliveryStatus.</b> Read-only. Reset: 0. 0=Idle. 1=Send Pending.                                                                                                                                                                                                                                                                                                                                             |      |            |      |            |      |       |      |     |      |                 |      |      |      |         |      |          |      |          |      |        |
| 11    | <b>DestinationMode.</b> Read-write. Reset: 0. 0=Physical. 1=Logical                                                                                                                                                                                                                                                                                                                                             |      |            |      |            |      |       |      |     |      |                 |      |      |      |         |      |          |      |          |      |        |
| 10:8  | <b>DeliveryMode.</b> Read-write. Reset: 0. <table><tr><th>Bits</th><th>Definition</th><th>Bits</th><th>Definition</th></tr><tr><td>000b</td><td>Fixed</td><td>100b</td><td>NMI</td></tr><tr><td>001b</td><td>Lowest Priority</td><td>101b</td><td>INIT</td></tr><tr><td>010b</td><td>SMI/PMI</td><td>110b</td><td>Reserved</td></tr><tr><td>011b</td><td>Reserved</td><td>111b</td><td>ExtINT</td></tr></table> | Bits | Definition | Bits | Definition | 000b | Fixed | 100b | NMI | 001b | Lowest Priority | 101b | INIT | 010b | SMI/PMI | 110b | Reserved | 011b | Reserved | 111b | ExtINT |
| Bits  | Definition                                                                                                                                                                                                                                                                                                                                                                                                      | Bits | Definition |      |            |      |       |      |     |      |                 |      |      |      |         |      |          |      |          |      |        |
| 000b  | Fixed                                                                                                                                                                                                                                                                                                                                                                                                           | 100b | NMI        |      |            |      |       |      |     |      |                 |      |      |      |         |      |          |      |          |      |        |
| 001b  | Lowest Priority                                                                                                                                                                                                                                                                                                                                                                                                 | 101b | INIT       |      |            |      |       |      |     |      |                 |      |      |      |         |      |          |      |          |      |        |
| 010b  | SMI/PMI                                                                                                                                                                                                                                                                                                                                                                                                         | 110b | Reserved   |      |            |      |       |      |     |      |                 |      |      |      |         |      |          |      |          |      |        |
| 011b  | Reserved                                                                                                                                                                                                                                                                                                                                                                                                        | 111b | ExtINT     |      |            |      |       |      |     |      |                 |      |      |      |         |      |          |      |          |      |        |
| 7:0   | <b>Vector.</b> Read-write. Reset: 0. Interrupt vector associated with this interrupt input                                                                                                                                                                                                                                                                                                                      |      |            |      |            |      |       |      |     |      |                 |      |      |      |         |      |          |      |          |      |        |

**NBIOAPICx20 IRQ Pin Assertion**

| Bits | Description                                                                                                                                                                                                                                                                                                         |
|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:8 | Reserved.                                                                                                                                                                                                                                                                                                           |
| 7:0  | <b>InputIrq.</b> Read-write. Reset: 0. IRQ number for the requested interrupt. A write to this register will trigger an interrupt associated with the redirection table entry referenced by the IRQ number. Currently the redirection table has 24 entries. Writes with IRQ number greater than 17h have no effect. |

**NBIOAPICx40 EOI**

| Bits | Description                                                                                                                                                                                                                                                                   |
|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:8 | Reserved.                                                                                                                                                                                                                                                                     |
| 7:0  | <b>Vector.</b> Write-only. Reset: 0. Interrupt vector. A write to this register will clear the remote IRR bit in the redirection table entry found matching the interrupt vector. This provides an alternate mechanism other than PCI special cycle for EOI to reach IOxAPIC. |

### 3.16 IOMMU Memory Mapped Registers

See 3.1 [Register Descriptions and Mnemonics] for a description of the register naming convention. See 2.12.1 [IOMMU Configuration Space].

#### IOMMUx00 Device Table Base Address Low

| Bits  | Description                                                                                                                                                                                                                                                                        |
|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:12 | <b>DevTblBase[31:12]: device table base address bits[31:12]</b> . Read-write. Reset: 0. DevTblBase[51:12] = {IOMMUx04[DevTblBase[51:32], DevTblBase[31:12]]}. DevTblBase[51:12] specifies the 4Kbyte-aligned base address of the first level device table.                         |
| 11:9  | Reserved.                                                                                                                                                                                                                                                                          |
| 8:0   | <b>DevTblSize: device table size</b> . Read-write. Reset: 0. This field contains 1 less than the length of the device table, in multiples of 4K bytes. A minimum size of 0 corresponds to a 4K byte device table and a maximum size of 1FFh corresponds to a 2M byte device table. |

#### IOMMUx04 Device Table Base Address High

| Bits  | Description                                                                                         |
|-------|-----------------------------------------------------------------------------------------------------|
| 31:20 | Reserved.                                                                                           |
| 19:0  | <b>DevTblBase[51:32]: device table base address bits[51:32]</b> . See: IOMMUx00[DevTblBase[31:12]]. |

#### IOMMUx08 Command Buffer Base Address Low

| Bits  | Description                                                                                                                                                                                                                         |
|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:12 | <b>ComBase[31:12]: command buffer base address bits[31:12]</b> . Read-write. Reset: 0. ComBase[51:12] = {IOMMUx0C[ComBase[51:32], ComBase[31:12]]}. ComBase[51:12] specifies the 4Kbyte-aligned base address of the command buffer. |
| 11:0  | Reserved.                                                                                                                                                                                                                           |

#### IOMMUx0C Command Buffer Base Address High

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |      |             |       |           |       |                                                              |
|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|-------|-----------|-------|--------------------------------------------------------------|
| 31:28 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |      |             |       |           |       |                                                              |
| 27:24 | <b>ComLen: command buffer length</b> . Read-write. Reset: 8h. Specifies the length of the command buffer in power of 2 increments. The minimum size is 256 entries (4K bytes); values less than 8h are reserved. <table border="1"> <thead> <tr> <th>Bits</th><th>Description</th></tr> </thead> <tbody> <tr> <td>7h-0h</td><td>Reserved.</td></tr> <tr> <td>Fh-8h</td><td>2<sup>ComLen</sup> entries (2<sup>ComLen</sup>*16 bytes).</td></tr> </tbody> </table> | Bits | Description | 7h-0h | Reserved. | Fh-8h | 2 <sup>ComLen</sup> entries (2 <sup>ComLen</sup> *16 bytes). |
| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |      |             |       |           |       |                                                              |
| 7h-0h | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |      |             |       |           |       |                                                              |
| Fh-8h | 2 <sup>ComLen</sup> entries (2 <sup>ComLen</sup> *16 bytes).                                                                                                                                                                                                                                                                                                                                                                                                                                    |      |             |       |           |       |                                                              |
| 23:20 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |      |             |       |           |       |                                                              |
| 19:0  | <b>ComBase[51:32]: command buffer base address bits[51:32]</b> . See: IOMMUx08[ComBase[31:12]].                                                                                                                                                                                                                                                                                                                                                                                                 |      |             |       |           |       |                                                              |

**IOMMUx10 Event Log Base Address Low**

| Bits  | Description                                                                                                                                                                                                                          |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:12 | <b>EventBase[31:12]: event log base address bits[31:12]</b> . Read-write. Reset: 0. EventBase[51:12] = {IOMMUx14[EventBase[51:32], EventBase[31:12]]}. EventBase[51:12] specifies the 4K-byte aligned base address of the event log. |
| 11:0  | Reserved.                                                                                                                                                                                                                            |

**IOMMUx14 Event Log Base Address High**

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                        |      |             |       |           |       |                                                                  |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|-------|-----------|-------|------------------------------------------------------------------|
| 31:28 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                          |      |             |       |           |       |                                                                  |
| 27:24 | <b>EventLen: event log length</b> . Read-write. Reset: 8h. Specifies the length of the event log in power of 2 increments. The minimum size is 256 entries (4K bytes); values less than 8h are reserved.<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>7h-0h</td><td>Reserved.</td></tr> <tr> <td>Fh-8h</td><td>2<sup>EventLen</sup> entries (2<sup>EventLen</sup>*16 bytes).</td></tr> </table> | Bits | Description | 7h-0h | Reserved. | Fh-8h | 2 <sup>EventLen</sup> entries (2 <sup>EventLen</sup> *16 bytes). |
| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                        |      |             |       |           |       |                                                                  |
| 7h-0h | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                          |      |             |       |           |       |                                                                  |
| Fh-8h | 2 <sup>EventLen</sup> entries (2 <sup>EventLen</sup> *16 bytes).                                                                                                                                                                                                                                                                                                                                                   |      |             |       |           |       |                                                                  |
| 23:20 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                          |      |             |       |           |       |                                                                  |
| 19:0  | <b>EventBase[51:32]: event log base address bits [51:32]</b> . See: IOMMUx10[EventBase[31:12]].                                                                                                                                                                                                                                                                                                                    |      |             |       |           |       |                                                                  |

**IOMMUx18 Control Low**

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:30 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 29    | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 28    | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 27:25 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 24    | <b>SmiFLogEn: SMI filter log enable</b> . Read-write. Reset: 0. Specifies if blocked SMI interrupts are reported in the IOMMU event log. When SmiFSup=00b, SmiFLogEn is ignored by hardware and may be implemented as a read-only value of 0b. 0b=SMI interrupts are not logged in the IOMMU event log (same behavior as IOMMU Revision 1). 1b=SMI interrupts blocked due to a match-failure with all valid (SmiDV=1b) SMI filter registers are reported in the IOMMU event log. |
| 23    | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 22    | <b>SmiFEn: SMI filter enable</b> . Read-write. Reset: 0. Specifies how SMI interrupts are controlled by the IOMMU. When SmiFSup=00b, SmiFEn is ignored by hardware and may be implemented as a read-only value of 0b. 0b=SMI interrupts are always passed-through (same behavior as IOMMU Revision 1). 1b=SMI interrupts are blocked unless otherwise controlled by the SMI Filter Registers and blocked SMI interrupts are reported in the event log as governed by SmiFLogEn.  |

|       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 21:18 | <b>Tlpt.</b> Read-write. Reset: 0. Tlpt contains the 4-bit value matched to the PCIe TLP Type field when the PCIe TLP Fmt value indicates the field carries a prefix.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 17    | <b>GaEn.</b> Read-write. Reset: 0. Guest APIC enable. 1 = loose. 0 = prohibited                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 16    | <b>GtEn.</b> Read-write. Reset: 0. 1=Guest translation may be enabled for a peripheral by programming DTE[GV]. This bit must be programmed to zero when <a href="#">IOMMUx30[GtSup]</a> =0.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 15    | <b>PprEn.</b> Read-write. Reset: 0. 1=Peripheral page service requests are processed. 0=Peripheral page service requests are treated as invalid device requests. This bit must be programmed to zero when <a href="#">IOMMUx30[PprSup]</a> =0.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| 14    | <b>PprIntEn.</b> Read-write. Reset: 0. 1=An interrupt is generated when <a href="#">IOMMUx2020[PprInt]</a> =1 or <a href="#">IOMMUx2020[PprOverflow]</a> =1. The interrupt vector used is indicated in <a href="#">D0F2x50[IommuM-siNumPpr]</a> . This bit must be programmed to zero when <a href="#">IOMMUx30[PprSup]</a> =0.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 13    | <b>PprLogEn.</b> Read-write. Reset: 0. 1=Peripheral page service request events are written to the peripheral page service request log when IommuEn=1. 0=Peripheral page service request logging is not enabled. Peripheral page service requests are discarded when PprLogEn=0 or <a href="#">IOMMUx30[PprSup]</a> =0. When IommuEn=1 and software sets PprLogEn, the IOMMU clears <a href="#">IOMMUx2020[PprOverflow]</a> and sets <a href="#">IOMMUx2020[PprRun]</a> . The IOMMU can then write new entries to the event log if there are usable entries available. Software can read <a href="#">IOMMUx2020[PprRun]</a> to determine the status of the peripheral page service request log. Note the peripheral page service request and event logs are independent. <a href="#">IOMMUx38</a> , <a href="#">IOMMUx2030</a> , and <a href="#">IOMMUx2038</a> must be programmed prior to setting PprLogEn. |
| 12    | <b>CmdBufEn.</b> Read-write. Reset: 0. 1=Start or restart command buffer processing. When CmdBufEn=1 and IommuEn=1, the IOMMU starts fetching commands and sets <a href="#">IOMMUx2020[CmdBufRun]</a> . 0=Halt command buffer processing. Writing a 0 to this bit causes the IOMMU to cease fetching new commands although commands previously fetched are completed. The IOMMU stops fetching commands upon reset and after errors. See <a href="#">IOMMUx2020[CmdBufRun]</a> . Writing of event log entries is independently controlled by EventLogEn. <a href="#">IOMMUx08</a> , <a href="#">IOMMUx0C</a> , <a href="#">IOMMUx2000</a> , and <a href="#">IOMMUx2008</a> must be programmed prior to setting CmdBufEn.                                                                                                                                                                                      |
| 11    | <b>Isoc.</b> Read-write. Reset: 0. This bit controls the state of the isochronous bit in the HyperTransport™ read request packet when the IOMMU issues I/O page table reads and device table reads on the HyperTransport link. 1=Request packet to use isochronous channel. 0=Request packet to use standard channel. If IOMMU isoc requests are enabled, then we must ensure the isoc channel is enabled as well. See <a href="#">D0F0x98_x1E[HiPriEn]</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| 10    | <b>Coherent.</b> Read-write. Reset: 1. This bit controls the state of the coherent bit in the HyperTransport read request packet when the IOMMU issues device table reads on the HyperTransport link. 1=Device table requests are snooped by the processor. 0=Device table requests are not snooped by the processor.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 9     | <b>ResPassPw.</b> Read-write. Reset: 0. This bit controls the state of the ResPassPW bit in the HyperTransport read request packet when the IOMMU issues I/O page table reads and device table reads on the HyperTransport link. 1=Response may pass posted requests. 0=Response may not pass posted requests.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| 8     | <b>PassPw.</b> Read-write. Reset: 0. This bit controls the state of the PassPW bit in the HyperTransport read request packet when the IOMMU issues I/O page table reads and device table reads on the HyperTransport link.. 1=Request packet may pass posted requests. 0=Request packet may not pass posted requests.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |



| 7:5       | <b>InvTimeout.</b> Read-write. Reset: 0. This field specifies the invalidation timeout for IOTLB invalidation requests.<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>000b</td><td>No timeout.</td></tr> <tr> <td>001b</td><td>1 ms.</td></tr> <tr> <td>010b</td><td>10 ms.</td></tr> <tr> <td>011b</td><td>100 ms.</td></tr> <tr> <td>100b</td><td>1 sec.</td></tr> <tr> <td>101b</td><td>10 sec.</td></tr> <tr> <td>111b-110b</td><td>Reserved</td></tr> </table>                                                                                                                | Bits | Description | 000b | No timeout. | 001b | 1 ms. | 010b | 10 ms. | 011b | 100 ms. | 100b | 1 sec. | 101b | 10 sec. | 111b-110b | Reserved |
|-----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|------|-------------|------|-------|------|--------|------|---------|------|--------|------|---------|-----------|----------|
| Bits      | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |      |             |      |             |      |       |      |        |      |         |      |        |      |         |           |          |
| 000b      | No timeout.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |      |             |      |             |      |       |      |        |      |         |      |        |      |         |           |          |
| 001b      | 1 ms.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |      |             |      |             |      |       |      |        |      |         |      |        |      |         |           |          |
| 010b      | 10 ms.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |      |             |      |             |      |       |      |        |      |         |      |        |      |         |           |          |
| 011b      | 100 ms.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |      |             |      |             |      |       |      |        |      |         |      |        |      |         |           |          |
| 100b      | 1 sec.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |      |             |      |             |      |       |      |        |      |         |      |        |      |         |           |          |
| 101b      | 10 sec.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |      |             |      |             |      |       |      |        |      |         |      |        |      |         |           |          |
| 111b-110b | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |      |             |      |             |      |       |      |        |      |         |      |        |      |         |           |          |
| 4         | <b>ComWaitIntEn.</b> Read-write. Reset: 0. 1=An interrupt is generated when <a href="#">IOMMUx2020[ComWaitInt]</a> =1.                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |      |             |      |             |      |       |      |        |      |         |      |        |      |         |           |          |
| 3         | <b>EventIntEn.</b> Read-write. Reset: 0. 1=An interrupt is generated when <a href="#">IOMMUx2020[EventLogInt]</a> =1 or <a href="#">IOMMUx2020[EventOverflow]</a> =1.                                                                                                                                                                                                                                                                                                                                                                                                                                |      |             |      |             |      |       |      |        |      |         |      |        |      |         |           |          |
| 2         | <b>EventLogEn.</b> Read-write. Reset: 0. 1=All events detected are written to the event log when <a href="#">IommuEn</a> =1. 0=Event logging is not enabled. Events are discarded when the event log is not enabled. When <a href="#">IommuEn</a> =1 and software sets <a href="#">EventLogEn</a> , the IOMMU clears <a href="#">IOMMUx2020[EventOverflow]</a> and sets <a href="#">IOMMUx2020[EventLogRun]</a> . <a href="#">IOMMUx10</a> , <a href="#">IOMMUx14</a> , <a href="#">IOMMUx2010</a> , and <a href="#">IOMMUx2018</a> must be programmed prior to setting <a href="#">EventLogEn</a> . |      |             |      |             |      |       |      |        |      |         |      |        |      |         |           |          |
| 1         | <b>HtTunEn.</b> Read-write. Reset: 0. 1= Upstream traffic received by the HyperTransport tunnel is translated by the IOMMU. 0=Upstream traffic received by the HyperTransport tunnel is not translated by the IOMMU. The IOMMU ignores the state of this bit while <a href="#">IommuEn</a> =0. See <a href="#">D0F2x40[IommuHtTunnelSup]</a> .                                                                                                                                                                                                                                                       |      |             |      |             |      |       |      |        |      |         |      |        |      |         |           |          |
| 0         | <b>IommuEn.</b> Read-write. Reset: 0. 1=IOMMU enabled. All upstream transactions are translated by the IOMMU. <a href="#">IOMMUx00 [Device Table Base Address Low]</a> and <a href="#">IOMMUx04 [Device Table Base Address High]</a> must be configured by software before setting this bit. 0=IOMMU is disabled and no upstream transactions are translated or remapped by the IOMMU. When disabled, the IOMMU does not read any commands or create any event log entries.                                                                                                                          |      |             |      |             |      |       |      |        |      |         |      |        |      |         |           |          |

### IOMMUx20 Exclusion Range Base Low

| Bits  | Description                                                                                                                                                                                                                                                                  |
|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:12 | <b>ExclBase[31:12]: exclusion range base address bits[31:12].</b> Read-write. Reset: 0. <a href="#">ExclBase[51:12]</a> = { <a href="#">IOMMUx20[ExclBase[51:32]]</a> , <a href="#">ExclBase[31:12]</a> }. Specifies the 4Kbyte-aligned base address of the exclusion range. |
| 11:2  | Reserved.                                                                                                                                                                                                                                                                    |
| 1     | <b>ExAllow: exclusion allow.</b> Read-write. Reset: 0. 1=All accesses to the exclusion range are forwarded untranslated. 0=The EX bit in the device table entry specifies if accesses to the exclusion range are translated.                                                 |
| 0     | <b>ExEn: exclusion enable.</b> Read-write. Reset: 0. 1=The exclusion range is enabled.                                                                                                                                                                                       |

### IOMMUx24 Exclusion Range Base High

| Bits | Description |
|------|-------------|
|------|-------------|

|       |                                                                                                                    |
|-------|--------------------------------------------------------------------------------------------------------------------|
| 31:20 | Reserved.                                                                                                          |
| 19:0  | <b>ExclBase[51:32]: exclusion range base address bits[51:32].</b> See: <a href="#">IOMMUx20[ExclBase[31:12]]</a> . |

### IOMMUx28 Exclusion Range Limit Low

| Bits  | Description                                                                                                                                                                                                                                                        |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:12 | <b>ExclLimit[31:12]: exclusion range limit address bits[31:12].</b> Read-write. Reset: 0. ExclLimit[51:12] = { <a href="#">IOMMUx2C[ExclLimit[51:32]]</a> , ExclLimit[31:12]}. ExclLimit[51:12] specifies the 4Kbyte-aligned limit address of the exclusion range. |
| 11:0  | Reserved.                                                                                                                                                                                                                                                          |

### IOMMUx2C Exclusion Range Limit High

| Bits  | Description                                                           |
|-------|-----------------------------------------------------------------------|
| 31:20 | Reserved.                                                             |
| 19:0  | <b>ExclLimitHi.</b> See: <a href="#">IOMMUx28[ExclLimit[31:12]]</a> . |

### IOMMUx30 Extended Feature Low

| Bits      | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |      |             |      |                                           |      |                                                                                       |         |                        |      |                        |      |                         |           |          |
|-----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|------|-------------------------------------------|------|---------------------------------------------------------------------------------------|---------|------------------------|------|------------------------|------|-------------------------|-----------|----------|
| 31:30     | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |      |             |      |                                           |      |                                                                                       |         |                        |      |                        |      |                         |           |          |
| 29:28     | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |      |             |      |                                           |      |                                                                                       |         |                        |      |                        |      |                         |           |          |
| 27:26     | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |      |             |      |                                           |      |                                                                                       |         |                        |      |                        |      |                         |           |          |
| 25:24     | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |      |             |      |                                           |      |                                                                                       |         |                        |      |                        |      |                         |           |          |
| 23:21     | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |      |             |      |                                           |      |                                                                                       |         |                        |      |                        |      |                         |           |          |
| 20:18     | <b>SmiFRC: SMI-Filter Register Count.</b> Read-only. Reset: 2. Indicates the number of SMI interrupt filter registers. SmiFRC must be 000b when SmiFSup=00b. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>000b</td><td>1 SMI filter registers</td></tr> <tr> <td>001b</td><td>2 SMI filter registers</td></tr> <tr> <td>010b</td><td>4 SMI filter registers</td></tr> <tr> <td>011b</td><td>8 SMI filter registers</td></tr> <tr> <td>100b</td><td>16 SMI filter registers</td></tr> <tr> <td>111b-101b</td><td>Reserved</td></tr> </table> | Bits | Description | 000b | 1 SMI filter registers                    | 001b | 2 SMI filter registers                                                                | 010b    | 4 SMI filter registers | 011b | 8 SMI filter registers | 100b | 16 SMI filter registers | 111b-101b | Reserved |
| Bits      | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |      |             |      |                                           |      |                                                                                       |         |                        |      |                        |      |                         |           |          |
| 000b      | 1 SMI filter registers                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |      |             |      |                                           |      |                                                                                       |         |                        |      |                        |      |                         |           |          |
| 001b      | 2 SMI filter registers                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |      |             |      |                                           |      |                                                                                       |         |                        |      |                        |      |                         |           |          |
| 010b      | 4 SMI filter registers                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |      |             |      |                                           |      |                                                                                       |         |                        |      |                        |      |                         |           |          |
| 011b      | 8 SMI filter registers                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |      |             |      |                                           |      |                                                                                       |         |                        |      |                        |      |                         |           |          |
| 100b      | 16 SMI filter registers                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |      |             |      |                                           |      |                                                                                       |         |                        |      |                        |      |                         |           |          |
| 111b-101b | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |      |             |      |                                           |      |                                                                                       |         |                        |      |                        |      |                         |           |          |
| 17:16     | <b>SmiFSup: SMI Filter Supported.</b> Read-only. Reset: 0. Specifies that SMI interrupts may be filtered. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>SMI interrupts are always passed-through.</td></tr> <tr> <td>01b</td><td>SMI interrupts are filtered under the control of SmiFEn and the SMI-filter registers.</td></tr> <tr> <td>11b-10b</td><td>Reserved</td></tr> </table>                                                                                                                                            | Bits | Description | 00b  | SMI interrupts are always passed-through. | 01b  | SMI interrupts are filtered under the control of SmiFEn and the SMI-filter registers. | 11b-10b | Reserved               |      |                        |      |                         |           |          |
| Bits      | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |      |             |      |                                           |      |                                                                                       |         |                        |      |                        |      |                         |           |          |
| 00b       | SMI interrupts are always passed-through.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |      |             |      |                                           |      |                                                                                       |         |                        |      |                        |      |                         |           |          |
| 01b       | SMI interrupts are filtered under the control of SmiFEn and the SMI-filter registers.                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |      |             |      |                                           |      |                                                                                       |         |                        |      |                        |      |                         |           |          |
| 11b-10b   | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |      |             |      |                                           |      |                                                                                       |         |                        |      |                        |      |                         |           |          |

| 15:14 | <b>GlxFup</b> . Read-only. Reset: 1.<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>GLX in the DTE is ignored and the IOMMU performs only single-level guest CR3 lookups. This value is not meaningful when GtSup=0.</td></tr> <tr> <td>01b</td><td>Two-level GCR3 base address table is supported in hardware.</td></tr> <tr> <td>10b</td><td>Three-level GCR3 base address table is supported in hardware for 20-bit PASID values.</td></tr> <tr> <td>11b</td><td>Reserved.</td></tr> </table>                                 | Bits | Description | 00b | GLX in the DTE is ignored and the IOMMU performs only single-level guest CR3 lookups. This value is not meaningful when GtSup=0. | 01b | Two-level GCR3 base address table is supported in hardware. | 10b | Three-level GCR3 base address table is supported in hardware for 20-bit PASID values. | 11b | Reserved. |
|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|-----|----------------------------------------------------------------------------------------------------------------------------------|-----|-------------------------------------------------------------|-----|---------------------------------------------------------------------------------------|-----|-----------|
| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |      |             |     |                                                                                                                                  |     |                                                             |     |                                                                                       |     |           |
| 00b   | GLX in the DTE is ignored and the IOMMU performs only single-level guest CR3 lookups. This value is not meaningful when GtSup=0.                                                                                                                                                                                                                                                                                                                                                                                                                              |      |             |     |                                                                                                                                  |     |                                                             |     |                                                                                       |     |           |
| 01b   | Two-level GCR3 base address table is supported in hardware.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |      |             |     |                                                                                                                                  |     |                                                             |     |                                                                                       |     |           |
| 10b   | Three-level GCR3 base address table is supported in hardware for 20-bit PASID values.                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |      |             |     |                                                                                                                                  |     |                                                             |     |                                                                                       |     |           |
| 11b   | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |      |             |     |                                                                                                                                  |     |                                                             |     |                                                                                       |     |           |
| 13:12 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |      |             |     |                                                                                                                                  |     |                                                             |     |                                                                                       |     |           |
| 11:10 | <b>HATS: host address translation size</b> . Read-only. Reset: 2.<br>The maximum number of host address translation levels supported. This value is not meaningful when GtSup=0. IOMMU behaviour is undefined if Next Level in a page directory entry exceeds the limit set by HATS. See <a href="#">D0F2x70</a> [HatsW].<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>4 levels.</td></tr> <tr> <td>01b</td><td>5 levels.</td></tr> <tr> <td>10b</td><td>6 levels.</td></tr> <tr> <td>11b</td><td>Reserved.</td></tr> </table> | Bits | Description | 00b | 4 levels.                                                                                                                        | 01b | 5 levels.                                                   | 10b | 6 levels.                                                                             | 11b | Reserved. |
| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |      |             |     |                                                                                                                                  |     |                                                             |     |                                                                                       |     |           |
| 00b   | 4 levels.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |      |             |     |                                                                                                                                  |     |                                                             |     |                                                                                       |     |           |
| 01b   | 5 levels.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |      |             |     |                                                                                                                                  |     |                                                             |     |                                                                                       |     |           |
| 10b   | 6 levels.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |      |             |     |                                                                                                                                  |     |                                                             |     |                                                                                       |     |           |
| 11b   | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |      |             |     |                                                                                                                                  |     |                                                             |     |                                                                                       |     |           |
| 9     | <b>PcSup: performance counters supported</b> . Read-only. Reset: 1. 1=performance counters are supported.                                                                                                                                                                                                                                                                                                                                                                                                                                                     |      |             |     |                                                                                                                                  |     |                                                             |     |                                                                                       |     |           |
| 8     | <b>HeSup: hardware error registers supported</b> . Read-only. Reset: 0. 0=Hardware error registers do not report error information. 1=Error information is reported in hardware error registers.                                                                                                                                                                                                                                                                                                                                                              |      |             |     |                                                                                                                                  |     |                                                             |     |                                                                                       |     |           |
| 7     | <b>GaSup: guest APIC supported</b> . Read-only. Reset: 0. 1=Guest APIC supported.                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |      |             |     |                                                                                                                                  |     |                                                             |     |                                                                                       |     |           |
| 6     | <b>IaSup: INVALIDATE_IOMMU_ALL supported</b> . Read-only. Reset: 1. 1=The INVALIDATE_IOMMU_ALL command is supported.                                                                                                                                                                                                                                                                                                                                                                                                                                          |      |             |     |                                                                                                                                  |     |                                                             |     |                                                                                       |     |           |
| 5     | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |      |             |     |                                                                                                                                  |     |                                                             |     |                                                                                       |     |           |
| 4     | <b>GtSup: guest translation supported</b> . Read-only. Reset: 1. 1=Guest address translation is supported. 0=Only nested address translation is supported. When GtSup=0, the following values in the DTE must be zero: GV, GLX and GCR3 Table Root Pointer. See <a href="#">IOMMUx18</a> [GtEn].                                                                                                                                                                                                                                                              |      |             |     |                                                                                                                                  |     |                                                             |     |                                                                                       |     |           |
| 3     | <b>NxSup: no execute supported</b> . Read-only. Reset: 0. 1=No-execute protection is supported. 0=No-execute protection is not supported.                                                                                                                                                                                                                                                                                                                                                                                                                     |      |             |     |                                                                                                                                  |     |                                                             |     |                                                                                       |     |           |
| 2     | <b>XtSup: x2 apic supported</b> . Read-only. Reset: 0. 1=The interrupt remapping table is expanded to support x2APIC interrupt information. 0=x2APIC support is disabled.                                                                                                                                                                                                                                                                                                                                                                                     |      |             |     |                                                                                                                                  |     |                                                             |     |                                                                                       |     |           |
| 1     | <b>PprSup: peripheral page service request supported</b> . Read-only. Reset: 1. 1=Indicates that IOMMU handles page service request events from peripherals, the IOMMU supports the page service request queue, and that the second IOMMU interrupt can be used to signal peripheral page service request events.                                                                                                                                                                                                                                             |      |             |     |                                                                                                                                  |     |                                                             |     |                                                                                       |     |           |
| 0     | <b>PrefSup: prefetch support</b> . Read-only. Reset: 1. 1=Indicates that IOMMU will accept PREFETCH_IOMMU_PAGES commands.                                                                                                                                                                                                                                                                                                                                                                                                                                     |      |             |     |                                                                                                                                  |     |                                                             |     |                                                                                       |     |           |

### IOMMUx34 Extended Feature High

| Bits | Description |
|------|-------------|
|------|-------------|

| 31:4  | Reserved.                                                                                                                                                                                                                                                                                                                                                                                              |      |             |       |           |       |                             |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|-------|-----------|-------|-----------------------------|
| 3:0   | <p><b>PasMax: PASID maximum.</b> Read-only. Reset: 8h. This specifies the maximum PASID value supported. This field is not meaningful when <a href="#">IOMMUx30</a>[GtSup]=0. See <a href="#">D0F2x74</a>[PasMaxW].</p> <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>2h-0h</td><td>Reserved.</td></tr> <tr> <td>Fh-3h</td><td><math>2^{(\text{PasMax}+1)}-1</math>.</td></tr> </table> | Bits | Description | 2h-0h | Reserved. | Fh-3h | $2^{(\text{PasMax}+1)}-1$ . |
| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                            |      |             |       |           |       |                             |
| 2h-0h | Reserved.                                                                                                                                                                                                                                                                                                                                                                                              |      |             |       |           |       |                             |
| Fh-3h | $2^{(\text{PasMax}+1)}-1$ .                                                                                                                                                                                                                                                                                                                                                                            |      |             |       |           |       |                             |

### IOMMUx38 PPR Log Base Address Low

| Bits  | Description                                                                                                                                                                                                                        |
|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:12 | <b>PprBase[31:12]: ppr base address bits[31:12].</b> Read-write. Reset: 0. PprBase[51:12] = { <a href="#">IOMMUx3C</a> [PprBase[51:32]], PprBase[31:12]}. PprBase[51:12] specifies the 4Kbyte-aligned base address of the PPR log. |
| 11:0  | Reserved.                                                                                                                                                                                                                          |

### IOMMUx3C PPR Log Base Address High

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                |      |             |       |           |       |                                                                     |
|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|-------|-----------|-------|---------------------------------------------------------------------|
| 31:28 | Reserved.                                                                                                                                                                                                                                                                                                                                                  |      |             |       |           |       |                                                                     |
| 27:24 | <p><b>PprLen: ppr length.</b> Read-write. Reset: 8h. Specifies the length of the PPR log in power of two increments.</p> <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>7h-0h</td><td>Reserved.</td></tr> <tr> <td>Fh-8h</td><td><math>2^{\text{PprLen}}</math> entries (<math>2^{\text{PprLen}} \times 16</math> bytes).</td></tr> </table> | Bits | Description | 7h-0h | Reserved. | Fh-8h | $2^{\text{PprLen}}$ entries ( $2^{\text{PprLen}} \times 16$ bytes). |
| Bits  | Description                                                                                                                                                                                                                                                                                                                                                |      |             |       |           |       |                                                                     |
| 7h-0h | Reserved.                                                                                                                                                                                                                                                                                                                                                  |      |             |       |           |       |                                                                     |
| Fh-8h | $2^{\text{PprLen}}$ entries ( $2^{\text{PprLen}} \times 16$ bytes).                                                                                                                                                                                                                                                                                        |      |             |       |           |       |                                                                     |
| 23:20 | Reserved.                                                                                                                                                                                                                                                                                                                                                  |      |             |       |           |       |                                                                     |
| 19:0  | <b>PprBase[51:32]: ppr base address bits[51:32].</b> See: <a href="#">IOMMUx38</a> [31:12].                                                                                                                                                                                                                                                                |      |             |       |           |       |                                                                     |

### IOMMUx40 Hardware Error Upper Low

| Bits | Description                                                                                                                                                                                                                                                                                                      |
|------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:0 | <b>FirstEvCode[31:0]: first event code bits[31:0].</b> Read-write. Reset: 0. FirstEvCode[59:0] = { <a href="#">IOMMUx44</a> [FirstEvCode[59:32]], FirstEvCode[31:0]}. <a href="#">IOMMUx44</a> [EvCode] and FirstEvCode[59:0] specify the upper 64 bits of the most recent hardware error detected by the IOMMU. |

### IOMMUx44 Hardware Error Upper High

| Bits  | Description                                                                                                 |
|-------|-------------------------------------------------------------------------------------------------------------|
| 31:28 | <b>EvCode: event code.</b> Read-write. Reset: 0. Event code for the type of error logged.                   |
| 27:0  | <b>FirstEvCode[59:32]: first event code bits[59:32].</b> See: <a href="#">IOMMUx40</a> [FirstEvCode[31:0]]. |

**IOMMUx48 Hardware Error Lower Low**

| Bits | Description                                                                                                                                                                                                                                                                     |
|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:0 | <b>SecondEvCode[31:0]: second event code bits[31:0]</b> . Read-write. Reset: 0. SecondEvCode[63:0] = { <a href="#">IOMMUx4C</a> [SecondEvCode[63:32]], SecondEvCode[31:0]}. SecondEvCode[63:0] specifies the lower 64 bits of the most recent hardware error detected by IOMMU. |

**IOMMUx4C Hardware Error Lower High**

| Bits | Description                                                                                                     |
|------|-----------------------------------------------------------------------------------------------------------------|
| 31:0 | <b>SecondEvCode[63:32]: second event code bits[63:32]</b> . See: <a href="#">IOMMUx48</a> [SecondEvCode[31:0]]. |

**IOMMUx50 Hardware Error Status**

| Bits | Description                                                                                                                                                                                                                                           |
|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:2 | Reserved.                                                                                                                                                                                                                                             |
| 1    | <b>HEO: hardware error overflow</b> . Read-write. Reset: 0. Defines the contents of the IOMMU hardware error registers as having been overwritten.. 0=not overwritten.. 1=contents overwritten by new information.. HEO is not meaningful when HEV=0. |
| 0    | <b>HEV: hardware error valid</b> . Read-write. Reset: 0. 1=Contents of the IOMMU hardware error registers are valid.                                                                                                                                  |

**IOMMUx[78,70,68,60] SMI Filter Low**Table 190: [Register Mapping](#) for [IOMMUx\[78,70,68,60\]](#)

| Register | Function     |
|----------|--------------|
| IOMMUx60 | SMI Filter 0 |
| IOMMUx68 | SMI Filter 1 |
| IOMMUx70 | SMI Filter 2 |
| IOMMUx78 | SMI Filter 3 |

| Bits  | Description                                                                                                                              |
|-------|------------------------------------------------------------------------------------------------------------------------------------------|
| 31:18 | Reserved.                                                                                                                                |
| 17    | <b>SMIFlock: SMI Filter Lock</b> . Read-write. Reset: 0. Makes SmiDV and SmiDID read-only.                                               |
| 16    | <b>SMIDV: SMI Device Valid</b> . Read-write. Reset: 0. The SMI filter is enabled and the device ID specified in SmiDID is valid for SMI. |
| 15:0  | <b>SMIDid: SMI Device ID</b> . Read-write. Reset: 0. Specifies the device ID for which SMIs are forwarded upstream.                      |

**IOMMUx[7C,74,6C,64] SMI Filter High**

Table 191: Register Mapping for IOMMUx[7C,74,6C,64]

| Register | Function     |
|----------|--------------|
| IOMMUx64 | SMI Filter 0 |
| IOMMUx6C | SMI Filter 1 |
| IOMMUx74 | SMI Filter 2 |
| IOMMUx7C | SMI Filter 3 |

| Bits | Description |
|------|-------------|
| 31:0 | Reserved.   |

**IOMMUx2000 Command Buffer Head Pointer**

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:19 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 18:4  | <b>CmdHdptr: command buffer head pointer.</b> Read-write; updated-by-hardware. Reset: 0. Specifies the 128-bit aligned offset from the command buffer base address register of the next command to be fetched by the IOMMU. The IOMMU increments this register, rolling over to zero at the end of the buffer, after fetching and validating the command in the command buffer. After incrementing this register, the IOMMU cannot re-fetch the command from the buffer. If this register is written by software while IOMMUx2020[CmdBufRun]=1, the IOMMU behavior is undefined. If this register is set by software to a value outside the length specified by IOMMUx0C[ComLen], the IOMMU behavior is undefined. |
| 3:0   | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |

**IOMMUx2008 Command Buffer Tail Pointer**

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:19 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| 18:4  | <b>CmdTailptr: command buffer tail pointer.</b> Read-write; updated-by-hardware. Reset: 0. Specifies the 128-bit aligned offset from the command buffer base address register of the next command to be written by the software. Software must increment this field, rolling over to zero at the end of the buffer, after writing a command to the command buffer. If software advances the tail pointer equal to or beyond the head pointer after adding one or more commands to the buffer, the IOMMU behavior is undefined. If software sets the command buffer tail pointer to an offset beyond the length of the command buffer, the IOMMU behavior is undefined. |
| 3:0   | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |

**IOMMUx2010 Event Log Head Pointer**

| Bits  | Description |
|-------|-------------|
| 31:19 | Reserved.   |

|      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 18:4 | <b>EventHdptr: event log head pointer.</b> Read-write. Reset: 0. Specifies the 128 bit aligned offset from the event log base address register that will be read next by software. Software must increment this field, rolling over at the end of the buffer, after reading an event from the event log. If software advances the head pointer beyond the tail pointer, the IOMMU behavior is undefined. If software sets the event log head pointer to an offset beyond the length of the event log, the IOMMU behavior is undefined. |
| 3:0  | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |

### IOMMUx2018 Event Log Tail Pointer

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:19 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 18:4  | <b>EventTailptr: event log tail pointer.</b> Read-write. Reset: 0. Specifies the 128-bit aligned offset from the event log base address register that will be written next by the IOMMU when an event is detected. The IOMMU increments this register, rolling over at the end of the buffer, after writing an event to the event log. If this register is written while <a href="#">IOMMUx2020[EventLogRun]=1</a> , the IOMMU behavior is undefined. If this register is set by software to a value outside the length specified by <a href="#">IOMMUx14[EventLen]</a> , the IOMMU behavior is undefined. |
| 3:0   | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |

### IOMMUx2020 Status

| Bits  | Description |
|-------|-------------|
| 31:19 | Reserved.   |
| 18    | Reserved.   |
| 17    | Reserved.   |
| 16    | Reserved.   |
| 15    | Reserved.   |
| 14:13 | Reserved.   |
| 12    | Reserved.   |
| 11    | Reserved.   |
| 10    | Reserved.   |
| 9     | Reserved.   |
| 8     | Reserved.   |

|   |                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|---|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 7 | <b>PprRun: peripheral page service request running.</b> Read-only. Reset: 0. 1=PPR requests are logged as they occur. 0=PPR requests are discarded without logging.. When PprOverflow=1, the IOMMU does not write new PPR log entries even when PprRun=1. When halted, PPR request logging is restarted by using <a href="#">IOMMUx18[PprLogEn]</a> .                                                                                |
| 6 | <b>PprInt: peripheral page service request interrupt.</b> Read-write; Write-1-to-clear. Reset: 0. 1=PPR request entry written to the PPR log by the IOMMU. 0=No PPR entry written to the PPR log by the IOMMU. See <a href="#">IOMMUx18[PprIntEn]</a> .                                                                                                                                                                              |
| 5 | <b>PprOverflow: peripheral page service request overflow.</b> Read-write; Write-1-to-clear. Reset: 0. 1=IOMMU PPR log overflow has occurred. This bit is set when a new peripheral page service request is to be written to the PPR log and there is no usable entry in the PPR log, causing the new information to be discarded. No new PPR log entries are written while this bit is set. See <a href="#">IOMMUx18[PprIntEn]</a> . |
| 4 | <b>CmdBufRun: command buffer running.</b> Read-only. Reset: 0. 1=Commands may be fetched from the command buffer. 0=IOMMU has stopped fetching new commands. The IOMMU freezes command processing after <code>COMMAND_HARDWARE_ERROR</code> or <code>ILLEGAL_COMMAND_ERROR</code> errors. When frozen, command fetching is restarted by using <a href="#">IOMMUx18[CmdBufEn]</a> .                                                   |
| 3 | <b>EventLogRun: event log running.</b> Read-only. Reset: 0. 1=Events are logged as they occur.. 0=Event reports are discarded without logging. When EventOverflow=1, the IOMMU does not write new event log entries even when EventLogRun=1. When halted, event logging is restarted by using <a href="#">IOMMUx18[EventLogEn]</a> .                                                                                                 |
| 2 | <b>ComWaitInt: completion wait interrupt.</b> Read-write; Write-1-to-clear. Reset: 0. 1=COMPLETION_WAIT command completed. This bit is only set if the i bit is set in the COMPLETION_WAIT command. See <a href="#">IOMMUx18[ComWaitIntEn]</a> .                                                                                                                                                                                     |
| 1 | <b>EventLogInt: event log interrupt.</b> Read-write; Write-1-to-clear. Reset: 0. 1=Event entry written to the event log by the IOMMU. See <a href="#">IOMMUx18[EventIntEn]</a> .                                                                                                                                                                                                                                                     |
| 0 | <b>EventOverflow.</b> Read-write; Write-1-to-clear. Reset: 0. 1=IOMMU event log overflow has occurred. This bit is set when a new event is to be written to the event log and there is no usable entry in the event log, causing the new event information to be discarded. No new event log entries are written while this bit is set. See <a href="#">IOMMUx18[EventIntEn]</a> .                                                   |

### IOMMUx2030 PPR Log Head Pointer

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:19 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 18:4  | <b>PprHdptr: ppr head pointer.</b> Read-write. Reset: 0. Specifies the 128-bit aligned offset from the PPR log base address register that will be read next by software. Software must increment this field, rolling over at the end of the buffer, after reading a PPR request entry from the PPR event log. If software advances the head pointer beyond the tail pointer, the IOMMU behavior is undefined. If software sets the PPR log head pointer to an offset beyond the length of the PPR log, the IOMMU behavior is undefined. |
| 3:0   | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |



**IOMMUx2038 PPR Log Tail Pointer**

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:19 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| 18:4  | <b>PprTailptr</b> . Read-write. Reset: 0. Specifies the 128-bit aligned offset from the PPR log base address register that will be written next by the IOMMU when a PPR request is detected. The IOMMU increments this register, rolling over at the end of the buffer, after writing a PPR request to the PPR log. If this register is written while <a href="#">IOMMUx2020[PprRun]=1</a> , the IOMMU behavior is undefined. If software sets the PPR log tail pointer to an offset beyond the length of the PPR log, defined by <a href="#">IOMMUx3C[PprLen]</a> , the IOMMU behavior is undefined. |
| 3:0   | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |

**IOMMUx4000 Counter Configuration**

| Bits        | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |             |                    |     |                             |         |                                                  |       |                                 |
|-------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|--------------------|-----|-----------------------------|---------|--------------------------------------------------|-------|---------------------------------|
| 31:18       | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |             |                    |     |                             |         |                                                  |       |                                 |
| 17:12       | <b>NCounterBanks: number of counter banks</b> . Read-only. Reset: 2h. The number of counter banks supported by the IOMMU. Each bank contains two or more counter and control registers as specified by NCounter. For each counter bank, a corresponding control bit is in <a href="#">IOMMUx4008</a> , <a href="#">IOMMUx4010</a> , and <a href="#">IOMMUx4018</a> . Each supported event counter bank is in a distinct, consecutive 4K byte page.<br><table> <tr> <td><u>Bits</u></td><td><u>Description</u></td></tr> <tr> <td>00h</td><td>No counter banks supported.</td></tr> <tr> <td>3Fh-01h</td><td>NCounterBanks event counter banks are supported.</td></tr> </table> Note: IOMMU event counter banks are numbered starting with 0. | <u>Bits</u> | <u>Description</u> | 00h | No counter banks supported. | 3Fh-01h | NCounterBanks event counter banks are supported. |       |                                 |
| <u>Bits</u> | <u>Description</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |             |                    |     |                             |         |                                                  |       |                                 |
| 00h         | No counter banks supported.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |             |                    |     |                             |         |                                                  |       |                                 |
| 3Fh-01h     | NCounterBanks event counter banks are supported.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |             |                    |     |                             |         |                                                  |       |                                 |
| 11          | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |             |                    |     |                             |         |                                                  |       |                                 |
| 10:7        | <b>NCounter: number of counters per bank</b> . Read-only. Reset: 4h. Reports the number of individual counters in each IOMMU counter bank. Each counter bank contains the same number of counters.<br><table> <tr> <td><u>Bits</u></td><td><u>Description</u></td></tr> <tr> <td>0h</td><td>No counters supported.</td></tr> <tr> <td>1h</td><td>Reserved.</td></tr> <tr> <td>Fh-2h</td><td>NCounter counters in each bank.</td></tr> </table>                                                                                                                                                                                                                                                                                                | <u>Bits</u> | <u>Description</u> | 0h  | No counters supported.      | 1h      | Reserved.                                        | Fh-2h | NCounter counters in each bank. |
| <u>Bits</u> | <u>Description</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |             |                    |     |                             |         |                                                  |       |                                 |
| 0h          | No counters supported.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |             |                    |     |                             |         |                                                  |       |                                 |
| 1h          | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |             |                    |     |                             |         |                                                  |       |                                 |
| Fh-2h       | NCounter counters in each bank.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |             |                    |     |                             |         |                                                  |       |                                 |
| 6:0         | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |             |                    |     |                             |         |                                                  |       |                                 |

**IOMMUx4008 Counter PASID Bank Lock Low**

| Bits | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:0 | <b>PasidLock[31:0]: pasid lock enable bits[31:0]</b> . Read-write. Reset: 0. PasidLock[63:0] = { <a href="#">IOMMUx400C[PasidLock[63:32]]</a> , PasidLock[31:0]}. For each bit in PasidLock[63:0], if the bit is set then writes to the corresponding bank in <a href="#">IOMMUx4[1,0][3:0]10</a> and <a href="#">IOMMUx4[1,0][3:0]14</a> are ignored. Bit positions above the value reported in <a href="#">IOMMUx4000[NCounterBanks]</a> are ignored when written and return zero when read. |

**IOMMUx400C Counter PASID Bank Lock High**

| Bits | Description                                                                  |
|------|------------------------------------------------------------------------------|
| 31:0 | <b>PasidLock[63:32]</b> . See: <a href="#">IOMMUx4008</a> [PasidLock[31:0]]. |

**IOMMUx4010 Domain Bank Lock Low**

| Bits | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:0 | <b>DomainLock[31:0]: domain lock enable bits[31:0]</b> . Read-write. Reset: 0. DomainLock[63:0] = { <a href="#">IOMMUx4014</a> [DomainLock[63:32]], DomainLock[31:0]}. For each bit in DomainLock[63:0], if the bit is set then writes to the corresponding bank in <a href="#">IOMMUx4[1,0][3:0]18</a> and <a href="#">IOMMUx4[1,0][3:0]1C</a> are ignored. Bit positions above the value reported in <a href="#">IOMMUx4000</a> [NCounterBanks] are ignored when written and return zero when read. |

**IOMMUx4014 Domain Bank Lock High**

| Bits | Description                                                                    |
|------|--------------------------------------------------------------------------------|
| 31:0 | <b>DomainLock[63:32]</b> . See: <a href="#">IOMMUx4010</a> [DomainLock[31:0]]. |

**IOMMUx4018 DeviceID Bank Lock Low**

| Bits | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:0 | <b>DevIDLock[31:0]: deviceID lock enable bits[31:0]</b> . Read-write. Reset: 0. DevIDLock[63:0] = { <a href="#">IOMMUx401C</a> [DevIDLock[63:32]], DevIDLock[31:0]}. For each bit in DevIDLock[63:0], if the bit is set then writes to the corresponding bank in <a href="#">IOMMUx4[1,0][3:0]20</a> and <a href="#">IOMMUx4[1,0][3:0]24</a> are ignored. Bit positions above the value reported in <a href="#">IOMMUx4000</a> [NCounterBanks] are ignored when written and return zero when read. |

**IOMMUx401C DeviceID Bank Lock High**

| Bits | Description                                                                  |
|------|------------------------------------------------------------------------------|
| 31:0 | <b>DevIDLock[63:32]</b> . See: <a href="#">IOMMUx4018</a> [DevIDLock[31:0]]. |

**IOMMUx4[1,0][3:0]00 Counter Low**Table 192: [Register Mapping](#) for [IOMMUx4\[1,0\]\[3:0\]00](#)

| Register    | Function         | Register    | Function         |
|-------------|------------------|-------------|------------------|
| IOMMUx40000 | Bank 0 Counter 0 | IOMMUx41000 | Bank 1 Counter 0 |
| IOMMUx40100 | Bank 0 Counter 1 | IOMMUx41100 | Bank 1 Counter 1 |
| IOMMUx40200 | Bank 0 Counter 2 | IOMMUx41200 | Bank 1 Counter 2 |
| IOMMUx40300 | Bank 0 Counter 3 | IOMMUx41300 | Bank 1 Counter 3 |

| Bits | Description                                                                                                                                                                                                                                                         |
|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:0 | <b>Icounter[31:0]</b> . Read-write. Reset: 0. Icounter[47:0] = {IOMMUx4[1,0][3:0]04[Icounter[47:32]], Icounter[31:0]}. Icounter[47:0] reports the counter value. The counter counts up continuously, wrapping at the maximum value. There is no overflow indicator. |

### IOMMUx4[1,0][3:0]04 Counter High

Table 193: Register Mapping for IOMMUx4[1,0][3:0]04

| Register    | Function         | Register    | Function         |
|-------------|------------------|-------------|------------------|
| IOMMUx40004 | Bank 0 Counter 0 | IOMMUx41004 | Bank 1 Counter 0 |
| IOMMUx40104 | Bank 0 Counter 1 | IOMMUx41104 | Bank 1 Counter 1 |
| IOMMUx40204 | Bank 0 Counter 2 | IOMMUx41204 | Bank 1 Counter 2 |
| IOMMUx40304 | Bank 0 Counter 3 | IOMMUx41304 | Bank 1 Counter 3 |

| Bits  | Description                                                        |
|-------|--------------------------------------------------------------------|
| 31:16 | Reserved.                                                          |
| 15:0  | <b>Icounter[47:32]</b> . See: IOMMUx4[1,0][3:0]00[Icounter[31:0]]. |

### IOMMUx4[1,0][3:0]08 Counter Source

Table 194: Register Mapping for IOMMUx4[1,0][3:0]08

| Register    | Function         | Register    | Function         |
|-------------|------------------|-------------|------------------|
| IOMMUx40008 | Bank 0 Counter 0 | IOMMUx41008 | Bank 1 Counter 0 |
| IOMMUx40108 | Bank 0 Counter 1 | IOMMUx41108 | Bank 1 Counter 1 |
| IOMMUx40208 | Bank 0 Counter 2 | IOMMUx41208 | Bank 1 Counter 2 |
| IOMMUx40308 | Bank 0 Counter 3 | IOMMUx41308 | Bank 1 Counter 3 |

| Bits | Description                                                                                                                           |
|------|---------------------------------------------------------------------------------------------------------------------------------------|
| 31   | <b>Cac: counter source architectural or custom</b> . Read-write. Reset: 0. 0=Architectural counter input group. 1=Custom input group. |
| 30   | <b>CountUnits</b> . Read-write. Reset: 0. 0=Counter counts events (level). 1=Counter counts clocks (edges).                           |
| 29:8 | Reserved.                                                                                                                             |
| 7:0  | <b>Csource: counter source</b> . Read-write. Reset: 0. Counter source. Selects event counter input from the choices provided.         |

### IOMMUx4[1,0][3:0]10 PASID Match Low

See IOMMUx4008.

Table 195: Register Mapping for IOMMUx4[1,0][3:0]10

| Register    | Function         | Register    | Function         |
|-------------|------------------|-------------|------------------|
| IOMMUx40010 | Bank 0 Counter 0 | IOMMUx41010 | Bank 1 Counter 0 |

Table 195: [Register Mapping](#) for IOMMUx4[1,0][3:0]10

|             |                  |             |                  |
|-------------|------------------|-------------|------------------|
| IOMMUx40110 | Bank 0 Counter 1 | IOMMUx41110 | Bank 1 Counter 1 |
| IOMMUx40210 | Bank 0 Counter 2 | IOMMUx41210 | Bank 1 Counter 2 |
| IOMMUx40310 | Bank 0 Counter 3 | IOMMUx41310 | Bank 1 Counter 3 |

| Bits  | Description                                                                                                                                                                                                                                                                  |
|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31    | <b>PasMEN: PASID match enable.</b> Read-write. Reset: 0. 0=PASID is ignored. 1=Filtered PASID must match to count an event. An event with no PASID tag is only counted when Pasm=0.                                                                                          |
| 30:16 | Reserved.                                                                                                                                                                                                                                                                    |
| 15:0  | <b>PasidMatch.</b> Read-write. Reset: 0. This value is compared with the masked (filtered) value of the incoming PASID of the transaction to decide if the corresponding event is counted. The event is counted if PasidMatch is exactly equal to the masked incoming PASID. |

**IOMMUx4[1,0][3:0]14 PASID Match High**See [IOMMUx4008](#).Table 196: [Register Mapping](#) for IOMMUx4[1,0][3:0]14

| Register    | Function         | Register    | Function         |
|-------------|------------------|-------------|------------------|
| IOMMUx40014 | Bank 0 Counter 0 | IOMMUx41014 | Bank 1 Counter 0 |
| IOMMUx40114 | Bank 0 Counter 1 | IOMMUx41114 | Bank 1 Counter 1 |
| IOMMUx40214 | Bank 0 Counter 2 | IOMMUx41214 | Bank 1 Counter 2 |
| IOMMUx40314 | Bank 0 Counter 3 | IOMMUx41314 | Bank 1 Counter 3 |

| Bits  | Description                                                                                                                                                                                                                                        |
|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:16 | Reserved.                                                                                                                                                                                                                                          |
| 15:0  | <b>PasidMask.</b> Read-write. Reset: 0. This bit-mask is ANDed with the PASID of the transaction to decide to count the corresponding event. 0=Count events for all values of incoming PASID. 0001h-FFFFh=Bit-wise mask ANDed with incoming PASID. |

**IOMMUx4[1,0][3:0]18 Domain Match Low**Table 197: [Register Mapping](#) for IOMMUx4[1,0][3:0]18

| Register    | Function         | Register    | Function         |
|-------------|------------------|-------------|------------------|
| IOMMUx40018 | Bank 0 Counter 0 | IOMMUx41018 | Bank 1 Counter 0 |
| IOMMUx40118 | Bank 0 Counter 1 | IOMMUx41118 | Bank 1 Counter 1 |
| IOMMUx40218 | Bank 0 Counter 2 | IOMMUx41218 | Bank 1 Counter 2 |
| IOMMUx40318 | Bank 0 Counter 3 | IOMMUx41318 | Bank 1 Counter 3 |

| Bits | Description                                                                                                                                |
|------|--------------------------------------------------------------------------------------------------------------------------------------------|
| 31   | <b>DomMEN: domain match enable.</b> Read-write. Reset: 0. 0=Domain is ignored. 1=Filtered Domain must match DomainMatch to count an event. |

|       |                                                                                                                                                                                                                                                                             |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 30:16 | Reserved.                                                                                                                                                                                                                                                                   |
| 15:0  | <b>DomainMatch.</b> Read-write. Reset: 0. This value is compared with the masked (filtered) value of the incoming Domain of the transaction to decide to count the corresponding event. The event is counted if DomainMatch is exactly equal to the masked incoming Domain. |

### IOMMUx4[1,0][3:0]1C Domain Match High

Table 198: Register Mapping for IOMMUx4[1,0][3:0]1C

| Register    | Function         | Register    | Function         |
|-------------|------------------|-------------|------------------|
| IOMMUx4001C | Bank 0 Counter 0 | IOMMUx4101C | Bank 1 Counter 0 |
| IOMMUx4011C | Bank 0 Counter 1 | IOMMUx4111C | Bank 1 Counter 1 |
| IOMMUx4021C | Bank 0 Counter 2 | IOMMUx4121C | Bank 1 Counter 2 |
| IOMMUx4031C | Bank 0 Counter 3 | IOMMUx4131C | Bank 1 Counter 3 |

| Bits  | Description                                                                                                                                                                                                                                                |
|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:16 | Reserved.                                                                                                                                                                                                                                                  |
| 15:0  | <b>DomainMask.</b> Read-write. Reset: 0. This bit-mask is ANDed with the Domain of the transaction to decide to count the corresponding event. 0000h=Count events for all values of incoming Domain. 0001h-FFFFh=Bit-wise mask ANDed with incoming Domain. |

### IOMMUx4[1,0][3:0]20 DeviceID Match Low

Table 199: Register Mapping for IOMMUx4[1,0][3:0]20

| Register    | Function         | Register    | Function         |
|-------------|------------------|-------------|------------------|
| IOMMUx40020 | Bank 0 Counter 0 | IOMMUx41020 | Bank 1 Counter 0 |
| IOMMUx40120 | Bank 0 Counter 1 | IOMMUx41120 | Bank 1 Counter 1 |
| IOMMUx40220 | Bank 0 Counter 2 | IOMMUx41220 | Bank 1 Counter 2 |
| IOMMUx40320 | Bank 0 Counter 3 | IOMMUx41320 | Bank 1 Counter 3 |

| Bits  | Description                                                                                                                                                                                                                                                                         |
|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31    | <b>DidMEN: deviceID match enable.</b> Read-write. Reset: 0. 0=DeviceID is ignored. 1=Filtered DeviceID must match to count an event.                                                                                                                                                |
| 30:16 | Reserved.                                                                                                                                                                                                                                                                           |
| 15:0  | <b>DeviceidMatch.</b> Read-write. Reset: 0. This value is compared with the masked (filtered) value of the incoming DeviceID of the transaction to decide to count the corresponding event. The event is counted if DeviceidMatch is exactly equal to the masked incoming DeviceID. |

### IOMMUx4[1,0][3:0]24 DeviceID Match High

Table 200: Register Mapping for IOMMUx4[1,0][3:0]24

| Register    | Function         | Register    | Function         |
|-------------|------------------|-------------|------------------|
| IOMMUx40024 | Bank 0 Counter 0 | IOMMUx41024 | Bank 1 Counter 0 |

Table 200: [Register Mapping](#) for IOMMUx4[1,0][3:0]24

|             |                  |             |                  |
|-------------|------------------|-------------|------------------|
| IOMMUx40124 | Bank 0 Counter 1 | IOMMUx41124 | Bank 1 Counter 1 |
| IOMMUx40224 | Bank 0 Counter 2 | IOMMUx41224 | Bank 1 Counter 2 |
| IOMMUx40324 | Bank 0 Counter 3 | IOMMUx41324 | Bank 1 Counter 3 |

| Bits  | Description                                                                                                                                                                                                                                                      |
|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:16 | Reserved.                                                                                                                                                                                                                                                        |
| 15:0  | <b>DeviceidMask</b> . Read-write. Reset: 0. This bit-mask is ANDed with the DeviceID of the transaction to decide to count the corresponding event. 0=Count events for all values of incoming DeviceID. 0001h-FFFFh= Bit-wise mask ANDed with incoming DeviceID. |

**IOMMUx4[1,0][3:0]28 Counter Report Low**Table 201: [Register Mapping](#) for IOMMUx4[1,0][3:0]28

| Register    | Function         | Register    | Function         |
|-------------|------------------|-------------|------------------|
| IOMMUx40028 | Bank 0 Counter 0 | IOMMUx41028 | Bank 1 Counter 0 |
| IOMMUx40128 | Bank 0 Counter 1 | IOMMUx41128 | Bank 1 Counter 1 |
| IOMMUx40228 | Bank 0 Counter 2 | IOMMUx41228 | Bank 1 Counter 2 |
| IOMMUx40328 | Bank 0 Counter 3 | IOMMUx41328 | Bank 1 Counter 3 |

| Bits | Description                                                                                                                                                                                                                                                                                         |
|------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:0 | <b>EventNote[31:0]</b> . Read-write. Reset: 0. EventNote[51:0] = {IOMMUx4[1,0][3:0]2C[Event-Note[51:32]], EventNote[31:0]}. When IOMMUx4[1,0][3:0]2C[CERE]=1 and the corresponding counter is incremented and wraps to zero, EventNote[51:0] is reported in the EVENT_COUNTER_ZERO event log entry. |

**IOMMUx4[1,0][3:0]2C Counter Report High**Table 202: [Register Mapping](#) for IOMMUx4[1,0][3:0]2C

| Register    | Function         | Register    | Function         |
|-------------|------------------|-------------|------------------|
| IOMMUx4002C | Bank 0 Counter 0 | IOMMUx4102C | Bank 1 Counter 0 |
| IOMMUx4012C | Bank 0 Counter 1 | IOMMUx4112C | Bank 1 Counter 1 |
| IOMMUx4022C | Bank 0 Counter 2 | IOMMUx4122C | Bank 1 Counter 2 |
| IOMMUx4032C | Bank 0 Counter 3 | IOMMUx4132C | Bank 1 Counter 3 |

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                           |
|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31    | <b>CERE: counter event report enable</b> . Read-write. Reset: 0. Counter Event Report Enable. 0=no event report when counter wraps to zero. 1=IOMMU writes an EVENT_COUNTER_ZERO event log entry when the counter wraps to zero. The counter-wrap event is treated like any other event. Software note: the counter-wrap event is delivered promptly but without a latency assurance. |
| 30:20 | Reserved.                                                                                                                                                                                                                                                                                                                                                                             |
| 19:0  | <b>EventNote[51:32]</b> . See: IOMMUx4[1,0][3:0]28[EventNote[31:0]].                                                                                                                                                                                                                                                                                                                  |



### 3.17 APIC Registers

See [2.4.9.1.2 \[APIC Register Space\]](#).

MMIO local APIC space is accessible in xAPIC mode.

#### APIC20 APIC ID

| Bits  | Description                                                                                                                                                                                                                                                                                                                                    |
|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:24 | <b>ApicId: APIC ID.</b> Read-write. Reset: Varies based on core number. <ul style="list-style-type: none"> <li>The initial value of <a href="#">APIC20[ApicId[7:0]]</a> is {0000b, CpuCoreNum[3:0]}.</li> </ul> See <a href="#">2.4.9.1.3 [ApicId Enumeration Requirements]</a> . See <a href="#">2.4.4 [Processor Cores and Downcoring]</a> . |
| 23:0  | Reserved.                                                                                                                                                                                                                                                                                                                                      |

#### APIC30 APIC Version

| Bits  | Description                                                                                                                                                                    |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31    | <b>ExtApicSpace: extended APIC register space present.</b> Read-only. Reset: 1. 1=Indicates the presence of extended APIC register space starting at <a href="#">APIC400</a> . |
| 30:25 | RAZ.                                                                                                                                                                           |
| 24    | <b>DirectedEoiSupport: directed EOI support.</b> Read-only. Reset: 0. 0=Directed EOI capability not supported.                                                                 |
| 23:16 | <b>MaxLvtEntry.</b> Read-only. Reset: Product-specific. Specifies the number of entries in the local vector table minus one.                                                   |
| 15:8  | RAZ.                                                                                                                                                                           |
| 7:0   | <b>Version.</b> Read-only. Reset: 10h. Indicates the version number of this APIC implementation.                                                                               |

#### APIC80 Task Priority (TPR)

| Bits | Description                                                                                                                             |
|------|-----------------------------------------------------------------------------------------------------------------------------------------|
| 31:8 | RAZ.                                                                                                                                    |
| 7:0  | <b>Priority.</b> Read-write. Reset: 0. This field is assigned by software to set a threshold priority at which the core is interrupted. |

#### APIC90 Arbitration Priority (APR)

| Bits | Description                                                                                                                                                                                                                                                      |
|------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:8 | RAZ.                                                                                                                                                                                                                                                             |
| 7:0  | <b>Priority.</b> Read-only. Reset: 0. Indicates the current priority for a pending interrupt, or a task or interrupt being serviced by the core. The priority is used to arbitrate between cores to determine which accepts a lowest-priority interrupt request. |



**APICA0 Processor Priority (PPR)**

| Bits | Description                                                                                                                                                                                                                                                                       |
|------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:8 | RAZ.                                                                                                                                                                                                                                                                              |
| 7:0  | <b>Priority.</b> Reset: 0. Read-only. Indicates the core's current priority servicing a task or interrupt, and is used to determine if any pending interrupts should be serviced. It is the higher value of the task priority value and the current highest in-service interrupt. |

**APICB0 End of Interrupt**

This register is written by the software interrupt handler to indicate the servicing of the current interrupt is complete.

| Bits | Description         |
|------|---------------------|
| 31:0 | Unused. Write-only. |

**APICC0 Remote Read**

| Bits | Description                                                                                                                        |
|------|------------------------------------------------------------------------------------------------------------------------------------|
| 31:0 | <b>RemoteReadData.</b> Read-only. Reset: 0. The data resulting from a valid completion of a remote read inter-processor interrupt. |

**APICD0 Logical Destination (LDR)**

| Bits  | Description                                                                                                                              |
|-------|------------------------------------------------------------------------------------------------------------------------------------------|
| 31:24 | <b>Destination.</b> Read-write. Reset: 0. This APIC's destination identification. Used to determine which interrupts should be accepted. |
| 23:0  | Reserved.                                                                                                                                |

**APICE0 Destination Format**

Only supported in xAPIC mode.

| Bits        | Description                                                                                                                                                                                                                                                                                                                                                               |             |                   |    |                               |       |          |    |                            |
|-------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|-------------------|----|-------------------------------|-------|----------|----|----------------------------|
| 31:28       | <b>Format.</b> Read-write. Reset: Fh. Controls which format to use when accepting interrupts with a logical destination mode.<br><table> <tr> <td><u>Bits</u></td><td><u>Definition</u></td></tr> <tr> <td>0h</td><td>Cluster destinations are used</td></tr> <tr> <td>Eh-1h</td><td>Reserved</td></tr> <tr> <td>Fh</td><td>Flat destinations are used</td></tr> </table> | <u>Bits</u> | <u>Definition</u> | 0h | Cluster destinations are used | Eh-1h | Reserved | Fh | Flat destinations are used |
| <u>Bits</u> | <u>Definition</u>                                                                                                                                                                                                                                                                                                                                                         |             |                   |    |                               |       |          |    |                            |
| 0h          | Cluster destinations are used                                                                                                                                                                                                                                                                                                                                             |             |                   |    |                               |       |          |    |                            |
| Eh-1h       | Reserved                                                                                                                                                                                                                                                                                                                                                                  |             |                   |    |                               |       |          |    |                            |
| Fh          | Flat destinations are used                                                                                                                                                                                                                                                                                                                                                |             |                   |    |                               |       |          |    |                            |
| 27:0        | Reserved. Reset: FFF_FFFFh.                                                                                                                                                                                                                                                                                                                                               |             |                   |    |                               |       |          |    |                            |

### APICF0 Spurious-Interrupt Vector (SVR)

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                          |
|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:13 | RAZ.                                                                                                                                                                                                                                                                                                                                                                 |
| 12    | <b>EoiBroadcastDisable: EOI broadcast disable.</b> Read-only. Reset: 0.                                                                                                                                                                                                                                                                                              |
| 11:10 | RAZ.                                                                                                                                                                                                                                                                                                                                                                 |
| 9     | <b>FocusDisable.</b> Read-write. Reset: 0. 1=Disable focus core checking during lowest-priority arbitrated interrupts.                                                                                                                                                                                                                                               |
| 8     | <b>APICSWEn: APIC software enable.</b> Read-write. Reset: 0. 0=SMI, NMI, INIT, LINT[1:0], and Startup interrupts may be accepted; pending interrupts in <a href="#">APIC[170:100]</a> and <a href="#">APIC[270:200]</a> are held, but further fixed, lowest-priority, and ExtInt interrupts are not accepted. All LVT entry mask bits are set and cannot be cleared. |
| 7:0   | <b>Vector.</b> Read-write. Reset: FFh. The vector that is sent to the core in the event of a spurious interrupt. The behavior of bits 3:0 are controlled as specified by <a href="#">D18F0x68[ApicExtSpur]</a> .                                                                                                                                                     |

### APIC[170:100] In-Service (ISR)

The in-service registers provide a bit per interrupt to indicate that the corresponding interrupt is being serviced by the core. APIC100[15:0] are reserved. Interrupts are mapped as follows:

Table 203: [Register Mapping](#) for [APIC\[170:100\]](#)

| Register | Function             |
|----------|----------------------|
| APIC100  | Interrupts [31:16]   |
| APIC110  | Interrupts [63:32]   |
| APIC120  | Interrupts [95:64]   |
| APIC130  | Interrupts [127:96]  |
| APIC140  | Interrupts [159:128] |
| APIC150  | Interrupts [191:160] |
| APIC160  | Interrupts [223:192] |
| APIC170  | Interrupts [255:224] |

| Bits | Description                                                                                                                   |
|------|-------------------------------------------------------------------------------------------------------------------------------|
| 31:0 | <b>InServiceBits.</b> Reset: 0. Read-only. These bits are set when the corresponding interrupt is being serviced by the core. |

### APIC[1F0:180] Trigger Mode (TMR)

The trigger mode registers provide a bit per interrupt to indicate the assertion mode of each interrupt. APIC180[15:0] are reserved. Interrupts are mapped as follows:

Table 204: [Register Mapping](#) for APIC[1F0:180]

| Register | Function             |
|----------|----------------------|
| APIC180  | Interrupts [31:16]   |
| APIC190  | Interrupts [63:32]   |
| APIC1A0  | Interrupts [95:64]   |
| APIC1B0  | Interrupts [127:96]  |
| APIC1C0  | Interrupts [159:128] |
| APIC1D0  | Interrupts [191:160] |
| APIC1E0  | Interrupts [223:192] |
| APIC1F0  | Interrupts [255:224] |

| Bits | Description                                                                                                                                                                                         |
|------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:0 | <b>TriggerModeBits</b> . Reset: 0. Read-only. The corresponding trigger mode bit is updated when an interrupt is accepted. The values are: 0=Edge-triggered interrupt. 1=Level-triggered interrupt. |

### APIC[270:200] Interrupt Request (IRR)

The interrupt request registers provide a bit per interrupt to indicate that the corresponding interrupt has been accepted by the APIC. APIC200[15:0] are reserved. Interrupts are mapped as follows:

Table 205: [Register Mapping](#) for APIC[270:200]

| Register | Function             |
|----------|----------------------|
| APIC200  | Interrupts [31:16]   |
| APIC210  | Interrupts [63:32]   |
| APIC220  | Interrupts [95:64]   |
| APIC230  | Interrupts [127:96]  |
| APIC240  | Interrupts [159:128] |
| APIC250  | Interrupts [191:160] |
| APIC260  | Interrupts [223:192] |
| APIC270  | Interrupts [255:224] |

| Bits | Description                                                                                                                   |
|------|-------------------------------------------------------------------------------------------------------------------------------|
| 31:0 | <b>RequestBits</b> . Read-only. Reset: 0. The corresponding request bit is set when the an interrupt is accepted by the APIC. |

### APIC280 Error Status

Writes to this register trigger an update of the register state. The value written by software is arbitrary. Each write causes the internal error state to be loaded into this register, clearing the internal error state. Consequently, a second write prior to the occurrence of another error causes the register to be overwritten with cleared data.

| Bits | Description |
|------|-------------|
| 31:8 | RAZ.        |

|     |                                                                                                                                                                                                                 |
|-----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 7   | <b>IllegalRegAddr: illegal register address.</b> Read-write. Reset: 0. This bit indicates that an access to a nonexistent register location within this APIC was attempted. Can only be set in xAPIC mode.      |
| 6   | <b>RcvdIllegalVector: received illegal vector.</b> Read-write. Reset: 0. This bit indicates that this APIC has received a message with an illegal vector (00h to 0Fh for fixed and lowest priority interrupts). |
| 5   | <b>SentIllegalVector.</b> Read-write. Reset: 0. This bit indicates that this APIC attempted to send a message with an illegal vector (00h to 0Fh for fixed and lowest priority interrupts).                     |
| 4   | RAZ.                                                                                                                                                                                                            |
| 3   | <b>RcvAcceptError: receive accept error.</b> Read-write. Reset: 0. This bit indicates that a message received by this APIC was not accepted by this or any other APIC.                                          |
| 2   | <b>SendAcceptError.</b> Read-write. Reset: 0. This bit indicates that a message sent by this APIC was not accepted by any APIC.                                                                                 |
| 1:0 | RAZ.                                                                                                                                                                                                            |

### APIC300 Interrupt Command Low (ICR Low)

Not all combinations of ICR fields are valid. Only the following combinations are valid:

**Table 206: ICR valid combinations**

| Message Type                    | Trigger Mode | Level  | Destination Shorthand              |
|---------------------------------|--------------|--------|------------------------------------|
| Fixed                           | Edge         | x      | x                                  |
|                                 | Level        | Assert | x                                  |
| Lowest Priority, SMI, NMI, INIT | Edge         | x      | Destination or all excluding self. |
|                                 | Level        | Assert | Destination or all excluding self  |
| Startup                         | x            | x      | Destination or all excluding self  |

Note: x indicates a don't care.

| Bits        | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |             |                    |     |                                  |     |      |     |                    |     |                                                                                                                                                                            |
|-------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|--------------------|-----|----------------------------------|-----|------|-----|--------------------|-----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:20       | RAZ.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |             |                    |     |                                  |     |      |     |                    |     |                                                                                                                                                                            |
| 19:18       | <p><b>DestShrthnd: destination shorthand.</b> Read-write. Reset: 0. Provides a quick way to specify a destination for a message.</p> <table> <tr> <th><u>Bits</u></th><th><u>Description</u></th></tr> <tr> <td>00b</td><td>No shorthand (Destination field)</td></tr> <tr> <td>01b</td><td>Self</td></tr> <tr> <td>10b</td><td>All including self</td></tr> <tr> <td>11b</td><td>All excluding self (This sends a message with a destination encoding of all 1s, so if lowest priority is used the message could end up being reflected back to this APIC.)</td></tr> </table> <p>If all including self or all excluding self is used, then destination mode is ignored and physical is automatically used.</p> | <u>Bits</u> | <u>Description</u> | 00b | No shorthand (Destination field) | 01b | Self | 10b | All including self | 11b | All excluding self (This sends a message with a destination encoding of all 1s, so if lowest priority is used the message could end up being reflected back to this APIC.) |
| <u>Bits</u> | <u>Description</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |             |                    |     |                                  |     |      |     |                    |     |                                                                                                                                                                            |
| 00b         | No shorthand (Destination field)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |             |                    |     |                                  |     |      |     |                    |     |                                                                                                                                                                            |
| 01b         | Self                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |             |                    |     |                                  |     |      |     |                    |     |                                                                                                                                                                            |
| 10b         | All including self                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |             |                    |     |                                  |     |      |     |                    |     |                                                                                                                                                                            |
| 11b         | All excluding self (This sends a message with a destination encoding of all 1s, so if lowest priority is used the message could end up being reflected back to this APIC.)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |             |                    |     |                                  |     |      |     |                    |     |                                                                                                                                                                            |

| 17:16 | <b>RemoteRdStat: remote read status.</b> Read-only. Reset: 0.<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>Read was invalid</td></tr> <tr> <td>01b</td><td>Delivery pending</td></tr> <tr> <td>10b</td><td>Delivery complete and access was valid</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>                                                                                                                                                  | Bits | Description | 00b  | Read was invalid | 01b  | Delivery pending | 10b  | Delivery complete and access was valid | 11b  | Reserved     |      |     |      |      |      |         |      |                     |
|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|------|------------------|------|------------------|------|----------------------------------------|------|--------------|------|-----|------|------|------|---------|------|---------------------|
| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |      |             |      |                  |      |                  |      |                                        |      |              |      |     |      |      |      |         |      |                     |
| 00b   | Read was invalid                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |      |             |      |                  |      |                  |      |                                        |      |              |      |     |      |      |      |         |      |                     |
| 01b   | Delivery pending                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |      |             |      |                  |      |                  |      |                                        |      |              |      |     |      |      |      |         |      |                     |
| 10b   | Delivery complete and access was valid                                                                                                                                                                                                                                                                                                                                                                                                                                                       |      |             |      |                  |      |                  |      |                                        |      |              |      |     |      |      |      |         |      |                     |
| 11b   | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |      |             |      |                  |      |                  |      |                                        |      |              |      |     |      |      |      |         |      |                     |
| 15    | <b>TM: trigger mode.</b> Read-write. Reset: 0. Indicates how this interrupt is triggered. 0=Edge triggered. 1=Level triggered.                                                                                                                                                                                                                                                                                                                                                               |      |             |      |                  |      |                  |      |                                        |      |              |      |     |      |      |      |         |      |                     |
| 14    | <b>Level.</b> Read-write. Reset: 0. 0=Deasserted. 1=Asserted.                                                                                                                                                                                                                                                                                                                                                                                                                                |      |             |      |                  |      |                  |      |                                        |      |              |      |     |      |      |      |         |      |                     |
| 13    | RAZ.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |      |             |      |                  |      |                  |      |                                        |      |              |      |     |      |      |      |         |      |                     |
| 12    | <b>DS: interrupt delivery status.</b> Read-only. Reset: 0. This bit is set to indicate that the interrupt has not yet been accepted by the destination core(s). 0=Idle. 1=Send pending. Software may repeatedly write ICRL without polling the DS bit; all requested IPIs will be delivered.                                                                                                                                                                                                 |      |             |      |                  |      |                  |      |                                        |      |              |      |     |      |      |      |         |      |                     |
| 11    | <b>DM: destination mode.</b> Read-write. Reset: 0. 0=Physical. 1=Logical.                                                                                                                                                                                                                                                                                                                                                                                                                    |      |             |      |                  |      |                  |      |                                        |      |              |      |     |      |      |      |         |      |                     |
| 10:8  | <b>MsgType.</b> Read-write. Reset: 0. The message types are encoded as follows:<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>000b</td><td>Fixed</td></tr> <tr> <td>001b</td><td>Lowest Priority.</td></tr> <tr> <td>010b</td><td>SMI</td></tr> <tr> <td>011b</td><td>Remote read.</td></tr> <tr> <td>100b</td><td>NMI</td></tr> <tr> <td>101b</td><td>INIT</td></tr> <tr> <td>110b</td><td>Startup</td></tr> <tr> <td>111b</td><td>External interrupt.</td></tr> </table> | Bits | Description | 000b | Fixed            | 001b | Lowest Priority. | 010b | SMI                                    | 011b | Remote read. | 100b | NMI | 101b | INIT | 110b | Startup | 111b | External interrupt. |
| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |      |             |      |                  |      |                  |      |                                        |      |              |      |     |      |      |      |         |      |                     |
| 000b  | Fixed                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |      |             |      |                  |      |                  |      |                                        |      |              |      |     |      |      |      |         |      |                     |
| 001b  | Lowest Priority.                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |      |             |      |                  |      |                  |      |                                        |      |              |      |     |      |      |      |         |      |                     |
| 010b  | SMI                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |      |             |      |                  |      |                  |      |                                        |      |              |      |     |      |      |      |         |      |                     |
| 011b  | Remote read.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |      |             |      |                  |      |                  |      |                                        |      |              |      |     |      |      |      |         |      |                     |
| 100b  | NMI                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |      |             |      |                  |      |                  |      |                                        |      |              |      |     |      |      |      |         |      |                     |
| 101b  | INIT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |      |             |      |                  |      |                  |      |                                        |      |              |      |     |      |      |      |         |      |                     |
| 110b  | Startup                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |      |             |      |                  |      |                  |      |                                        |      |              |      |     |      |      |      |         |      |                     |
| 111b  | External interrupt.                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |      |             |      |                  |      |                  |      |                                        |      |              |      |     |      |      |      |         |      |                     |
| 7:0   | <b>Vector.</b> Read-write. Reset: 0. The vector that is sent for this interrupt source.                                                                                                                                                                                                                                                                                                                                                                                                      |      |             |      |                  |      |                  |      |                                        |      |              |      |     |      |      |      |         |      |                     |

### APIC310 Interrupt Command High (ICR High)

| Bits  | Description                                                                                                                    |
|-------|--------------------------------------------------------------------------------------------------------------------------------|
| 31:24 | <b>DestinationField.</b> Read-write. Reset: 0. The destination encoding used when <a href="#">APIC300[DestShrthnd]</a> is 00b. |
| 23:0  | RAZ.                                                                                                                           |

### APIC320 LVT Timer

| Bits  | Description                                                                                                                                                                   |
|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:18 | RAZ.                                                                                                                                                                          |
| 17    | <b>Mode.</b> Read-write. Reset: 0. 0=One-shot. 1=Periodic.                                                                                                                    |
| 16    | <b>Mask.</b> Read-write. Reset: 1. 0=Not masked. 1=Masked.                                                                                                                    |
| 15:13 | RAZ.                                                                                                                                                                          |
| 12    | <b>DS: interrupt delivery status.</b> Read-only; updated-by-hardware. Reset: 0. 0=Idle. 1=Send pending. (Indicates that the interrupt has not yet been accepted by the core.) |
| 11    | RAZ.                                                                                                                                                                          |

|      |                                                                                                                          |
|------|--------------------------------------------------------------------------------------------------------------------------|
| 10:8 | <b>MsgType: message type.</b> Read-write. Reset: 000b. See <a href="#">2.4.9.1.14 [Generalized Local Vector Table]</a> . |
| 7:0  | <b>Vector.</b> Read-write. Reset: 00h. Interrupt vector number.                                                          |

### APIC330 LVT Thermal Sensor

Interrupts for this local vector table are caused by changes in [MSRC001\\_0061\[CurPstateLimit\]](#) due to SB-RMI or HTC.

| Bits  | Description                                                                                                                                                                   |
|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:17 | RAZ.                                                                                                                                                                          |
| 16    | <b>Mask.</b> Read-write. Reset: 1. 0=Not masked. 1=Masked.                                                                                                                    |
| 15:13 | RAZ.                                                                                                                                                                          |
| 12    | <b>DS: interrupt delivery status.</b> Read-only; updated-by-hardware. Reset: 0. 0=Idle. 1=Send pending. (Indicates that the interrupt has not yet been accepted by the core.) |
| 11    | RAZ.                                                                                                                                                                          |
| 10:8  | <b>MsgType: message type.</b> Read-write. Reset: 000b. See <a href="#">2.4.9.1.14 [Generalized Local Vector Table]</a> .                                                      |
| 7:0   | <b>Vector.</b> Read-write. Reset: 00h. Interrupt vector number.                                                                                                               |

### APIC340 LVT Performance Monitor

Interrupts for this local vector table are caused by overflows of:

- [MSRC001\\_00\[07:04\] \[Performance Event Counter \(PERF\\_CTR\[3:0\]\)\]](#).
- [MSRC001\\_020\[B,9,7,5,3,1\] \[Performance Event Counter \(PERF\\_CTR\[5:0\]\)\]](#).
- [MSRC001\\_024\[7,5,3,1\] \[Northbridge Performance Event Counter \(NB\\_PERF\\_CTR\[3:0\]\)\]](#).

| Bits  | Description                                                                                                                                                                   |
|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:17 | RAZ.                                                                                                                                                                          |
| 16    | <b>Mask.</b> Read-write. Reset: 1. 0=Not masked. 1=Masked.                                                                                                                    |
| 15:13 | RAZ.                                                                                                                                                                          |
| 12    | <b>DS: interrupt delivery status.</b> Read-only; updated-by-hardware. Reset: 0. 0=Idle. 1=Send pending. (Indicates that the interrupt has not yet been accepted by the core.) |
| 11    | RAZ.                                                                                                                                                                          |
| 10:8  | <b>MsgType: message type.</b> Read-write. Reset: 000b. See <a href="#">2.4.9.1.14 [Generalized Local Vector Table]</a> .                                                      |
| 7:0   | <b>Vector.</b> Read-write. Reset: 00h. Interrupt vector number.                                                                                                               |

### APIC3[60:50] LVT LINT[1:0]

Table 207: [Register Mapping](#) for APIC3[60:50]

| Register | Function |
|----------|----------|
| APIC350  | LINT 0   |
| APIC360  | LINT 1   |

| Bits  | Description                                                                                                                                                                                              |
|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:17 | RAZ.                                                                                                                                                                                                     |
| 16    | <b>Mask.</b> Read-write. Reset: 1. 0=Not masked. 1=Masked.                                                                                                                                               |
| 15    | <b>TM: trigger mode.</b> Read-write. Reset: 0. 0=Edge. 1=Level.                                                                                                                                          |
| 14    | <b>RmtIRR.</b> Read-only; updated-by-hardware. Reset: 0. If trigger mode is level, remote IRR is set when the interrupt has begun service. Remote IRR is cleared when the end of interrupt has occurred. |
| 13    | Reserved.                                                                                                                                                                                                |
| 12    | <b>DS: interrupt delivery status.</b> Read-only; updated-by-hardware. Reset: 0. 0=Idle. 1=Send pending. (Indicates that the interrupt has not yet been accepted by the core.)                            |
| 11    | RAZ.                                                                                                                                                                                                     |
| 10:8  | <b>MsgType: message type.</b> Read-write. Reset: 000b. See <a href="#">2.4.9.1.14 [Generalized Local Vector Table]</a> .                                                                                 |
| 7:0   | <b>Vector.</b> Read-write. Reset: 00h. Interrupt vector number.                                                                                                                                          |

### APIC370 LVT Error

| Bits  | Description                                                                                                                                                                   |
|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:17 | RAZ.                                                                                                                                                                          |
| 16    | <b>Mask.</b> Read-write. Reset: 1. 0=Not masked. 1=Masked.                                                                                                                    |
| 15:13 | Reserved.                                                                                                                                                                     |
| 12    | <b>DS: interrupt delivery status.</b> Read-only; updated-by-hardware. Reset: 0. 0=Idle. 1=Send pending. (Indicates that the interrupt has not yet been accepted by the core.) |
| 11    | RAZ.                                                                                                                                                                          |
| 10:8  | <b>MsgType: message type.</b> Read-write. Reset: 000b. See <a href="#">2.4.9.1.14 [Generalized Local Vector Table]</a> .                                                      |
| 7:0   | <b>Vector.</b> Read-write. Reset: 00h. Interrupt vector number.                                                                                                               |

### APIC380 Timer Initial Count

| Bits | Description                                                                                                                |
|------|----------------------------------------------------------------------------------------------------------------------------|
| 31:0 | <b>Count.</b> Read-write. Reset: 0. The value copied into the current count register when the timer is loaded or reloaded. |

### APIC390 Timer Current Count

| Bits | Description                                                          |
|------|----------------------------------------------------------------------|
| 31:0 | <b>Count.</b> Read-only. Reset: 0. The current value of the counter. |

### APIC3E0 Timer Divide Configuration

The Div bits are encoded as follows:

**Table 208: Div[3,1:0] Value Table**

| Div[3] | Div[1:0] | Resulting Timer Divide |
|--------|----------|------------------------|
| 0      | 00b      | 2                      |
| 0      | 01b      | 4                      |
| 0      | 10b      | 8                      |
| 0      | 11b      | 16                     |
| 1      | 00b      | 32                     |
| 1      | 01b      | 64                     |
| 1      | 10b      | 128                    |
| 1      | 11b      | 1                      |

| Bits | Description                                                             |
|------|-------------------------------------------------------------------------|
| 31:4 | RAZ.                                                                    |
| 3    | <b>Div[3]</b> . Read-write. Reset: 0. See <a href="#">Table 208</a> .   |
| 2    | RAZ.                                                                    |
| 1:0  | <b>Div[1:0]</b> . Read-write. Reset: 0. See <a href="#">Table 208</a> . |

**APIC400 Extended APIC Feature**

| Bits  | Description                                                                                                                                                                                                           |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:24 | RAZ.                                                                                                                                                                                                                  |
| 23:16 | <b>ExtLvtCount: extended local vector table count</b> . Read-only. Reset: 04h. This specifies the number of extended LVT registers ( <a href="#">APIC[530:500]</a> ) in the local APIC.                               |
| 15:3  | RAZ.                                                                                                                                                                                                                  |
| 2     | <b>ExtApicIdCap: extended APIC ID capable</b> . Read-only. Reset: 1. 1=The processor is capable of supporting an 8-bit APIC ID, as controlled by <a href="#">APIC410[ExtApicIdEn]</a> .                               |
| 1     | <b>SeoiCap: specific end of interrupt capable</b> . Read-only. Reset: 1. 1=The <a href="#">APIC420 [Specific End Of Interrupt]</a> is present.                                                                        |
| 0     | <b>IerCap: interrupt enable register capable</b> . Read-only. Reset: 1. This bit indicates that the <a href="#">APIC[4F0:480] [Interrupt Enable]</a> are present. See <a href="#">2.4.9.1.8 [Interrupt Masking]</a> . |

**APIC410 Extended APIC Control**

| Bits | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:3 | RAZ.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 2    | <b>ExtApicIdEn: extended APIC ID enable</b> . Read-write. Reset: 0. 1=Enable 8-bit APIC ID; <a href="#">APIC20[ApicId]</a> supports an 8-bit value; an interrupt broadcast in physical destination mode requires that the <code>IntDest[7:0]=1111_1111b</code> (instead of <code>xxxx_1111b</code> ); a match in physical destination mode occurs when <code>(IntDest[7:0] == ApicId[7:0])</code> instead of <code>(IntDest[3:0] == ApicId[3:0])</code> . If <code>ExtApicIdEn=1</code> then program <a href="#">D18F0x68[ApicExtId]=1</a> and <a href="#">D18F0x68[ApicExtBrdCst]=1</a> . |



|   |                                                                                                                                                |
|---|------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | <b>SeoiEn.</b> Read-write. Reset: 0. 1=Enable SEOI generation when a write to <a href="#">APIC420 [Specific End Of Interrupt]</a> is received. |
| 0 | <b>IerEn.</b> Read-write. Reset: 0. 1=Enable writes to the interrupt enable registers.                                                         |

### APIC420 Specific End Of Interrupt

| Bits | Description                                                                                                                                                                                                                                                           |
|------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:8 | RAZ.                                                                                                                                                                                                                                                                  |
| 7:0  | <b>EoiVec: end of interrupt vector.</b> Read-write. Reset: 0. A write to this field causes an end of interrupt cycle to be performed for the vector specified in this field. The behavior is undefined if no interrupt is pending for the specified interrupt vector. |

### APIC[4F0:480] Interrupt Enable

Interrupt enables range is mapped as follows:

Table 209: [Register Mapping](#) for APIC[4F0:480]

| Register | Function       |
|----------|----------------|
| APIC480  | IntEn[31:0]    |
| APIC490  | IntEn[63:32]   |
| APIC4A0  | IntEn[95:64]   |
| APIC4B0  | IntEn[127:96]  |
| APIC4C0  | IntEn[159:128] |
| APIC4D0  | IntEn[191:160] |
| APIC4E0  | IntEn[223:192] |
| APIC4F0  | IntEn[255:224] |

| Bits | Description                                                                                                                                             |
|------|---------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:0 | <b>InterruptEnableBits.</b> Read-write. Reset: FFFF_FFFFh. The interrupt enable bits can be used to enable each of the 256 interrupts. See above table. |

### APIC[530:500] Extended Interrupt [3:0] Local Vector Table

APIC500 provides a local vector table entry for IBS; See [D18F3x1CC](#). APIC510 provides a local vector table entry for error thresholding. The APIC[530:520] registers are unused.

Table 210: [Register Mapping](#) for APIC[530:500]

| Register | Function                            |
|----------|-------------------------------------|
| APIC500  | Extended Interrupt 0 (IBS)          |
| APIC510  | Extended Interrupt 1 (Thresholding) |
| APIC520  | Extended Interrupt 2                |
| APIC530  | Extended Interrupt 3                |

| Bits  | Description                                                                                                                                                                   |
|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:17 | RAZ.                                                                                                                                                                          |
| 16    | <b>Mask.</b> Read-write. Reset: 1. 0=Not masked. 1=Masked.                                                                                                                    |
| 15:13 | RAZ.                                                                                                                                                                          |
| 12    | <b>DS: interrupt delivery status.</b> Read-only; updated-by-hardware. Reset: 0. 0=Idle. 1=Send pending. (Indicates that the interrupt has not yet been accepted by the core.) |
| 11    | RAZ.                                                                                                                                                                          |
| 10:8  | <b>MsgType: message type.</b> Read-write. Reset: 000b. See <a href="#">2.4.9.1.14 [Generalized Local Vector Table]</a> .                                                      |
| 7:0   | <b>Vector.</b> Read-write. Reset: 00h. Interrupt vector number.                                                                                                               |

### 3.18 CPUID Instruction Registers

Processor feature capabilities and configuration information are provided through the CPUID instruction. The information is accessed by (1) selecting the CPUID function setting EAX and optionally ECX for some functions, (2) executing the CPUID instruction, and (3) reading the results in the EAX, EBX, ECX, and EDX registers. The syntax *CPUID FnXXXX\_XXXX\_EiX[\_xYYY]* refers to the function where EAX==X, and optionally ECX==Y, and the registers specified by EiX. EiX can be any single register such as {EAX, EBX, ECX, and EDX}, or a range of registers, such as E[C,B,A]X. Undefined function numbers return 0's in all 4 registers. See [2.4.11 \[CPUID Instruction\]](#).

Unless otherwise specified, single-bit feature fields are encoded as 1=Feature is supported by the processor; 0=Feature is not supported by the processor.

The following provides processor specific details about CPUID.

#### **CPUID Fn0000\_0000\_EAX Processor Vendor and Largest Standard Function Number**

| Bits | Description                                                                                                                                               |
|------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:0 | <b>LFuncStd: largest standard function.</b> Value: 0000_000Dh. The largest CPUID standard function input value supported by the processor implementation. |

#### **CPUID Fn0000\_0000\_E[D,C,B]X Processor Vendor**

[CPUID Fn0000\\_0000\\_E\[D,C,B\]X](#) and [CPUID Fn8000\\_0000\\_E\[D,C,B\]X](#) return the same value.

**Table 211: Reset Mapping for [CPUID Fn8000\\_0000\\_E\[D,C,B\]X](#)**

| Register              | Value      | Description                     |
|-----------------------|------------|---------------------------------|
| CPUID Fn0000_0000_EBX | 6874_7541h | The ASCII characters “h t u A”. |
| CPUID Fn0000_0000_ECX | 444D_4163h | The ASCII characters “D M A c”. |
| CPUID Fn0000_0000_EDX | 6974_6E65h | The ASCII characters “i t n e”. |

| Bits | Description                                                                            |
|------|----------------------------------------------------------------------------------------|
| 31:0 | <b>Vendor.</b> The 12 8-bit ASCII character codes to create the string “AuthenticAMD”. |

**CPUID Fn0000\_0001\_EAX Family, Model, Stepping Identifiers**

Also see [CPUID Fn8000\\_0001\\_EAX \[Family, Model, Stepping Identifiers\]](#).

**Family** is an 8-bit value and is defined as: **Family[7:0]** = ({0000b, BaseFamily[3:0]} + ExtendedFamily[7:0]). E.g. If BaseFamily[3:0]=Fh and ExtendedFamily[7:0]=07h, then Family[7:0]=16h.

**Model** is an 8-bit value and is defined as: **Model[7:0]** = {ExtendedModel[3:0], BaseModel[3:0]}. E.g. If ExtendedModel[3:0]=Eh and BaseModel[3:0]=8h, then Model[7:0] = E8h. Model numbers vary with product.

| Bits  | Description                                                                                                                              |
|-------|------------------------------------------------------------------------------------------------------------------------------------------|
| 31:28 | Reserved.                                                                                                                                |
| 27:20 | <b>ExtFamily: extended family.</b> <a href="#">CPUID Fn0000_0001_EAX[ExtFamily]</a> is an alias of <a href="#">D18F3xFC[ExtFamily]</a> . |
| 19:16 | <b>ExtModel: extended model.</b> <a href="#">CPUID Fn0000_0001_EAX[ExtModel]</a> is an alias of <a href="#">D18F3xFC[ExtModel]</a> .     |
| 15:12 | Reserved.                                                                                                                                |
| 11:8  | <b>BaseFamily.</b> <a href="#">CPUID Fn0000_0001_EAX[BaseFamily]</a> is an alias of <a href="#">D18F3xFC[BaseFamily]</a> .               |
| 7:4   | <b>BaseModel.</b> <a href="#">CPUID Fn0000_0001_EAX[BaseModel]</a> is an alias of <a href="#">D18F3xFC[BaseModel]</a> .                  |
| 3:0   | <b>Stepping.</b> <a href="#">CPUID Fn0000_0001_EAX[Stepping]</a> is an alias of <a href="#">D18F3xFC[Stepping]</a> .                     |

**CPUID Fn0000\_0001\_EBX LocalApicId, LogicalProcessorCount, CLFlush**

| Bits  | Description                                                                                                                                                                                                   |
|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:24 | <b>LocalApicId: initial local APIC physical ID.</b> The initial <a href="#">APIC20[ApicId]</a> value. See <a href="#">2.4.4 [Processor Cores and Downcoring]</a> .                                            |
| 23:16 | <b>LogicalProcessorCount: logical processor count.</b> Value: <a href="#">CPUID Fn8000_0008_ECX[NC]</a> + 1. Specifies the number of cores in the processor as <a href="#">CPUID Fn8000_0008_ECX[NC]</a> + 1. |
| 15:8  | <b>CLFlush: CLFLUSH size in quadwords.</b> Value: 08h.                                                                                                                                                        |
| 7:0   | <b>8BitBrandId: 8 bit brand ID.</b> Value: 00h. Indicates that the brand ID is in <a href="#">CPUID Fn8000_0001_EBX</a> .                                                                                     |

**CPUID Fn0000\_0001\_ECX Feature Identifiers**

These values can be over-written by [MSRC001\\_1004](#).

| Bits | Description                                                           |
|------|-----------------------------------------------------------------------|
| 31   | RAZ. Reserved for use by hypervisor to indicate guest status.         |
| 30   | <b>RDRAND: RDRAND instruction support.</b><br>Value: 0.               |
| 29   | <b>F16C: half-precision convert instruction support.</b><br>Value: 1. |

|       |                                                                                                                                                                                          |
|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 28    | <b>AVX: AVX instruction support.</b> Value: 1.<br>Value: 1.                                                                                                                              |
| 27    | <b>OSXSAVE: OS enabled support for XGETBV/XSETBV.</b> 1=The OS has enabled support for XGETBV/XSETBV instructions to query processor extended states.                                    |
| 26    | <b>XSAVE: XSAVE (and related) instruction support.</b><br>Value: 1.<br>1=Support provided for the XSAVE, XRSTOR, XSETBV, and XGETBV instructions and the XFEATURE_ENABLED_MASK register. |
| 25    | <b>AES: AES instruction support.</b> Value: Product-specific.                                                                                                                            |
| 24    | Reserved.                                                                                                                                                                                |
| 23    | <b>POPCNT: POPCNT instruction.</b> Value: 1.                                                                                                                                             |
| 22    | <b>MOVBE: MOVBE instruction support.</b><br>Value: 0.                                                                                                                                    |
| 21    | <b>x2APIC: x2APIC capability.</b><br>Value: 0.                                                                                                                                           |
| 20    | <b>SSE42: SSE4.2 instruction support.</b><br>Value: 1.                                                                                                                                   |
| 19    | <b>SSE41: SSE4.1 instruction support.</b><br>Value: 1.                                                                                                                                   |
| 18    | Reserved.                                                                                                                                                                                |
| 17    | <b>PCID: process context identifiers support.</b><br>Value: 0.                                                                                                                           |
| 16:14 | Reserved.                                                                                                                                                                                |
| 13    | <b>CMPXCHG16B: CMPXCHG16B instruction.</b> Value: 1.                                                                                                                                     |
| 12    | <b>FMA: FMA instruction support.</b><br>Value: 1.                                                                                                                                        |
| 11:10 | Reserved.                                                                                                                                                                                |
| 9     | <b>SSSE3: supplemental SSE3 extensions.</b> Value: 1.                                                                                                                                    |
| 8:4   | Reserved.                                                                                                                                                                                |
| 3     | <b>Monitor: Monitor/Mwait instructions.</b> Value: ~MSRC001_0015[MonMwaitDis].                                                                                                           |
| 2     | Reserved.                                                                                                                                                                                |
| 1     | <b>PCLMULQDQ: PCLMULQDQ instruction support.</b> Value: Product-specific.                                                                                                                |
| 0     | <b>SSE3: SSE3 extensions.</b> Value: 1.                                                                                                                                                  |

**CPUID Fn0000\_0001\_EDX Feature Identifiers**

These values can be over-written by [MSRC001\\_1004](#).

| Bits  | Description                                                                                                                                                                                                                                   |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:29 | Reserved.                                                                                                                                                                                                                                     |
| 28    | <b>HTT: hyper-threading technology.</b> Value: <a href="#">CPUID Fn8000_0008_ECX[NC]</a> !=0. 1=Multi core product ( <a href="#">CPUID Fn8000_0008_ECX[NC]</a> != 0). 0=Single core product ( <a href="#">CPUID Fn8000_0008_ECX[NC]</a> ==0). |
| 27    | Reserved.                                                                                                                                                                                                                                     |
| 26    | <b>SSE2: SSE2 extensions.</b> Value: 1.                                                                                                                                                                                                       |
| 25    | <b>SSE: SSE extensions.</b> Value: 1.                                                                                                                                                                                                         |
| 24    | <b>FXSR: FXSAVE and FXRSTOR instructions.</b> Value: 1.                                                                                                                                                                                       |
| 23    | <b>MMX: MMX™ instructions.</b> Value: 1.                                                                                                                                                                                                      |
| 22:20 | Reserved.                                                                                                                                                                                                                                     |
| 19    | <b>CLFSH: CLFLUSH instruction.</b> Value: 1.                                                                                                                                                                                                  |
| 18    | Reserved.                                                                                                                                                                                                                                     |
| 17    | <b>PSE36: page-size extensions.</b> Value: 1.                                                                                                                                                                                                 |
| 16    | <b>PAT: page attribute table.</b> Value: 1.                                                                                                                                                                                                   |
| 15    | <b>CMOV: conditional move instructions, CMOV, FCOMI, FCMOV.</b> Value: 1.                                                                                                                                                                     |
| 14    | <b>MCA: machine check architecture, MCG_CAP.</b> Value: 1.                                                                                                                                                                                    |
| 13    | <b>PGE: page global extension, CR4.PGE.</b> Value: 1.                                                                                                                                                                                         |
| 12    | <b>MTRR: memory-type range registers.</b> Value: 1.                                                                                                                                                                                           |
| 11    | <b>SysEnterSysExit: SYSENTER and SYSEXIT instructions.</b> Value: 1.                                                                                                                                                                          |
| 10    | Reserved.                                                                                                                                                                                                                                     |
| 9     | <b>APIC: advanced programmable interrupt controller (APIC) exists and is enabled.</b> Value: <a href="#">MSR0000_001B[ApicEn]</a> .                                                                                                           |
| 8     | <b>CMPXCHG8B: CMPXCHG8B instruction.</b> Value: 1.                                                                                                                                                                                            |
| 7     | <b>MCE: machine check exception, CR4.MCE.</b> Value: 1.                                                                                                                                                                                       |
| 6     | <b>PAE: physical-address extensions (PAE).</b> Value: 1.                                                                                                                                                                                      |
| 5     | <b>MSR: AMD model-specific registers (MSRs), with RDMSR and WRMSR instructions.</b> Value: 1.                                                                                                                                                 |
| 4     | <b>TSC: time stamp counter, RDTSC/RDTSCP instructions, CR4.TSD.</b> Value: 1.                                                                                                                                                                 |
| 3     | <b>PSE: page-size extensions (4 MB pages).</b> Value: 1.                                                                                                                                                                                      |
| 2     | <b>DE: debugging extensions, IO breakpoints, CR4.DE.</b> Value: 1.                                                                                                                                                                            |
| 1     | <b>VME: virtual-mode enhancements.</b> Value: 1.                                                                                                                                                                                              |
| 0     | <b>FPU: x87 floating point unit on-chip.</b> Value: 1.                                                                                                                                                                                        |

**CPUID Fn0000\_000[4:2] Reserved**

| Bits | Description |
|------|-------------|
| 31:0 | Reserved.   |

**CPUID Fn0000\_0005\_EAX Monitor/MWait**

| Bits  | Description                                                             |
|-------|-------------------------------------------------------------------------|
| 31:16 | Reserved.                                                               |
| 15:0  | <b>MonLineSizeMin: smallest monitor-line size in bytes.</b> Value: 40h. |

**CPUID Fn0000\_0005\_EBX Monitor/MWait**

| Bits  | Description                                                            |
|-------|------------------------------------------------------------------------|
| 31:16 | Reserved.                                                              |
| 15:0  | <b>MonLineSizeMax: largest monitor-line size in bytes.</b> Value: 40h. |

**CPUID Fn0000\_0005\_ECX Monitor/MWait**

| Bits | Description                                               |
|------|-----------------------------------------------------------|
| 31:2 | Reserved.                                                 |
| 1    | <b>IBE: interrupt break-event.</b> Value: 1.              |
| 0    | <b>EMX: enumerate MONITOR/MWAIT extensions.</b> Value: 1. |

**CPUID Fn0000\_0005\_EDX Monitor/MWait**

| Bits | Description |
|------|-------------|
| 31:0 | Reserved.   |

**CPUID Fn0000\_0006\_EAX Thermal and Power Management**

| Bits | Description                                                                                                        |
|------|--------------------------------------------------------------------------------------------------------------------|
| 31:3 | Reserved.                                                                                                          |
| 2    | <b>ARAT: always running APIC timer.</b><br>Value: 0.<br>1=Indicates support for APIC timer always running feature. |
| 1:0  | Reserved.                                                                                                          |

**CPUID Fn0000\_0006\_EBX Thermal and Power Management**

| Bits | Description |
|------|-------------|
| 31:0 | Reserved.   |

**CPUID Fn0000\_0006\_ECX Thermal and Power Management**

These values can be over-written by [MSRC001\\_1003](#).

| Bits | Description                                                                                                                                                                                                                                        |
|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:1 | Reserved.                                                                                                                                                                                                                                          |
| 0    | <b>EffFreq: effective frequency interface.</b> Value: 1. 1=Indicates presence of <a href="#">MSR0000_00E7</a> [Max Performance Frequency Clock Count (MPERF)] and <a href="#">MSR0000_00E8</a> [Actual Performance Frequency Clock Count (APERF)]. |

**CPUID Fn0000\_0006\_EDX Thermal and Power Management**

| Bits | Description |
|------|-------------|
| 31:0 | Reserved.   |

**CPUID Fn0000\_0007\_EAX\_x0 Structured Extended Feature Identifiers (ECX=0)**

| Bits | Description |
|------|-------------|
| 31:0 | Reserved.   |

**CPUID Fn0000\_0007\_EBX\_x0 Structured Extended Feature Identifiers (ECX=0)**

| Bits  | Description                                                             |
|-------|-------------------------------------------------------------------------|
| 31:11 | Reserved.                                                               |
| 10    | <b>INVPCID: invalidate processor context ID.</b><br>Value: 0.           |
| 9     | Reserved.                                                               |
| 8     | <b>BMI2: bit manipulation group 2 instruction support.</b><br>Value: 0. |
| 7     | <b>SMEP: supervisor mode execution protection.</b><br>Value: 0.         |
| 6     | Reserved.                                                               |

|     |                                                                              |
|-----|------------------------------------------------------------------------------|
| 5   | <b>AVX2: AVX extension support.</b><br>Value: 0.                             |
| 4   | Reserved.                                                                    |
| 3   | <b>BMI1: bit manipulation group 1 instruction support.</b><br>Value: 1.      |
| 2:1 | Reserved.                                                                    |
| 0   | <b>FSGSBASE: FS and GS base read write instruction support.</b><br>Value: 1. |

---

**CPUID Fn0000\_0007\_ECX\_x0 Structured Extended Feature Identifiers (ECX=0)**


---

|      |             |
|------|-------------|
| Bits | Description |
| 31:0 | Reserved.   |

---

**CPUID Fn0000\_0007\_EDX\_x0 Structured Extended Feature Identifiers (ECX=0)**


---

|      |             |
|------|-------------|
| Bits | Description |
| 31:0 | Reserved.   |

---

**CPUID Fn0000\_000[A:8] Reserved**


---

|      |             |
|------|-------------|
| Bits | Description |
| 31:0 | Reserved.   |

---

**CPUID Fn0000\_000B Reserved**


---

|      |             |
|------|-------------|
| Bits | Description |
| 31:0 | Reserved.   |

---

**CPUID Fn0000\_000C Reserved**


---

|      |             |
|------|-------------|
| Bits | Description |
| 31:0 | Reserved.   |



**CPUID Fn0000\_000D\_EAX\_x0 Processor Extended State Enumeration (ECX=0)**

| Bits | Description                                             |
|------|---------------------------------------------------------|
| 31:0 | <b>XFeatureSupportedMask[31:0]</b> . Value: 0000_0007h. |

**CPUID Fn0000\_000D\_EBX\_x0 Processor Extended State Enumeration (ECX=0)**

| Bits | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:0 | <p><b>XFeatureEnabledSizeMax</b>. Size in bytes of XSAVE/XRSTOR area for the currently enabled features in XCR0.<br/> Value: 512 + 64 + (IF (XCR0[AVX]   XCR0[LWP]) THEN 256 ELSE 0 ENDIF) + (IF XCR0[LWP]) THEN 128 ELSE 0 ENDIF).</p> <p>The components of this sum are described as follows:</p> <ul style="list-style-type: none"> <li>• 512: FPU/SSE save area (needed even if XCR0[SSE]=0)</li> <li>• 64: Header size (always needed).</li> <li>• Size of YMM area if YMM enabled.</li> <li>• Size of LWP area if LWP enabled.</li> </ul> |

**CPUID Fn0000\_000D\_ECX\_x0 Processor Extended State Enumeration (ECX=0)**

| Bits | Description                                                                                                                                                             |
|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:0 | <p><b>XFeatureSupportedSizeMax</b>. Size in bytes of XSAVE/XRSTOR area for all features that the core supports. See XFeatureEnabledSizeMax.<br/> Value: 0000_03C0h.</p> |

**CPUID Fn0000\_000D\_EDX\_x0 Processor Extended State Enumeration (ECX=0)**

| Bits | Description                                                         |
|------|---------------------------------------------------------------------|
| 31:0 | <p><b>XFeatureSupportedMask[63:32]</b>.<br/> Value: 4000_0000h.</p> |

**CPUID Fn0000\_000D\_EAX\_x1 Processor Extended State Enumeration (ECX=1)**

| Bits | Description                                                   |
|------|---------------------------------------------------------------|
| 31:1 | Reserved.                                                     |
| 0    | <p><b>XSAVEOPT</b>: XSAVEOPT is available.<br/> Value: 1.</p> |

**CPUID Fn0000\_000D\_E[D,C,B]X\_x1 Processor Extended State Enumeration (ECX=1)**

| Bits | Description |
|------|-------------|
| 31:0 | Reserved.   |

**CPUID Fn0000\_000D\_EAX\_x2 Processor Extended State Enumeration (ECX=2)**

| Bits | Description                                                           |
|------|-----------------------------------------------------------------------|
| 31:0 | <b>YmmSaveStateSize:</b> YMM save state byte size. Value: 0000_0100h. |

**CPUID Fn0000\_000D\_EBX\_x2 Processor Extended State Enumeration (ECX=2)**

| Bits | Description                                                               |
|------|---------------------------------------------------------------------------|
| 31:0 | <b>YmmSaveStateOffset:</b> YMM save state byte offset. Value: 0000_0240h. |

**CPUID Fn0000\_000D\_ECX\_x2 Processor Extended State Enumeration (ECX=2)**

| Bits | Description |
|------|-------------|
| 31:0 | Reserved.   |

**CPUID Fn0000\_000D\_EDX\_x2 Processor Extended State Enumeration (ECX=2)**

| Bits | Description |
|------|-------------|
| 31:0 | Reserved.   |

For CPUID Fn0000\_000D, if ECX>2 and ECX<62 then EAX/EBX/ECX/EDX will return 0.

**CPUID Fn0000\_000D\_EAX\_x3E Processor Extended State Enumeration (ECX=62)**

| Bits | Description                                                           |
|------|-----------------------------------------------------------------------|
| 31:0 | <b>LwpSaveStateSize:</b> LWP save state byte size. Value: 0000_0080h. |

**CPUID Fn0000\_000D\_EBX\_x3E Processor Extended State Enumeration (ECX=62)**

| Bits | Description                                                               |
|------|---------------------------------------------------------------------------|
| 31:0 | <b>LwpSaveStateOffset:</b> LWP save state byte offset. Value: 0000_0340h. |

**CPUID Fn0000\_000D\_ECX\_x3E Processor Extended State Enumeration (ECX=62)**

| Bits | Description |
|------|-------------|
| 31:0 | Reserved.   |

**CPUID Fn0000\_000D\_EDX\_x3E Processor Extended State Enumeration (ECX=62)**

| Bits | Description |
|------|-------------|
| 31:0 | Reserved.   |

For CPUID Fn0000\_000D, if ECX>62 then EAX/EBX/ECX/EDX will return 0.

**CPUID Fn8000\_0000\_EAX Largest Extended Function Number**

| Bits | Description                                                                                                                                               |
|------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:0 | <b>LFuncExt: largest extended function.</b> Value: 8000_001Eh. The largest CPUID extended function input value supported by the processor implementation. |

**CPUID Fn8000\_0000\_E[D,C,B]X Processor Vendor**

[CPUID Fn0000\\_0000\\_E\[D,C,B\]X](#) and [CPUID Fn8000\\_0000\\_E\[D,C,B\]X](#) return the same value.

**Table 212: CPUID Fn8000\_0000\_E[B,C,D]X Value**

| Register              | Value      | Description                     |
|-----------------------|------------|---------------------------------|
| CPUID Fn8000_0000_EBX | 6874_7541h | The ASCII characters “h t u A”. |
| CPUID Fn8000_0000_ECX | 444D_4163h | The ASCII characters “D M A c”. |
| CPUID Fn8000_0000_EDX | 6974_6E65h | The ASCII characters “i t n e”. |

| Bits | Description                                                                            |
|------|----------------------------------------------------------------------------------------|
| 31:0 | <b>Vendor.</b> The 12 8-bit ASCII character codes to create the string “AuthenticAMD”. |

**CPUID Fn8000\_0001\_EAX Family, Model, Stepping Identifiers**

Also see [CPUID Fn0000\\_0001\\_EAX \[Family, Model, Stepping Identifiers\]](#).

| Bits  | Description                                                                                                                              |
|-------|------------------------------------------------------------------------------------------------------------------------------------------|
| 31:28 | Reserved.                                                                                                                                |
| 27:20 | <b>ExtFamily: extended family.</b> <a href="#">CPUID Fn8000_0001_EAX[ExtFamily]</a> is an alias of <a href="#">D18F3xFC[ExtFamily]</a> . |
| 19:16 | <b>ExtModel: extended model.</b> <a href="#">CPUID Fn8000_0001_EAX[ExtModel]</a> is an alias of <a href="#">D18F3xFC[ExtModel]</a> .     |
| 15:12 | Reserved.                                                                                                                                |
| 11:8  | <b>BaseFamily.</b> <a href="#">CPUID Fn8000_0001_EAX[BaseFamily]</a> is an alias of <a href="#">D18F3xFC[BaseFamily]</a> .               |

|     |                                                                                                                          |
|-----|--------------------------------------------------------------------------------------------------------------------------|
| 7:4 | <b>BaseModel.</b> <a href="#">CPUID Fn8000_0001_EAX</a> [BaseModel] is an alias of <a href="#">D18F3xFC</a> [BaseModel]. |
| 3:0 | <b>Stepping.</b> <a href="#">CPUID Fn8000_0001_EAX</a> [Stepping] is an alias of <a href="#">D18F3xFC</a> [Stepping].    |

### **CPUID Fn8000\_0001\_EBX BrandId Identifier**

| Bits        | Description                                                                                                                                                                                                                                                                                    |             |                    |    |           |    |              |       |           |
|-------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|--------------------|----|-----------|----|--------------|-------|-----------|
| 31:28       | <b>PkgType: package type.</b> Specifies the package type.<br>Value: Product-specific. <table> <tr> <th><u>Bits</u></th><th><u>Description</u></th></tr> <tr> <td>0h</td><td>FP3 (BGA)</td></tr> <tr> <td>1h</td><td>FM2r2 (uPGA)</td></tr> <tr> <td>Fh-2h</td><td>Reserved.</td></tr> </table> | <u>Bits</u> | <u>Description</u> | 0h | FP3 (BGA) | 1h | FM2r2 (uPGA) | Fh-2h | Reserved. |
| <u>Bits</u> | <u>Description</u>                                                                                                                                                                                                                                                                             |             |                    |    |           |    |              |       |           |
| 0h          | FP3 (BGA)                                                                                                                                                                                                                                                                                      |             |                    |    |           |    |              |       |           |
| 1h          | FM2r2 (uPGA)                                                                                                                                                                                                                                                                                   |             |                    |    |           |    |              |       |           |
| Fh-2h       | Reserved.                                                                                                                                                                                                                                                                                      |             |                    |    |           |    |              |       |           |
| 27:0        | Reserved.                                                                                                                                                                                                                                                                                      |             |                    |    |           |    |              |       |           |

### **CPUID Fn8000\_0001\_ECX Feature Identifiers**

These values can be over-written by [MSRC001\\_1005](#).

| Bits  | Description                                                                                                                                                                                     |
|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:29 | Reserved.                                                                                                                                                                                       |
| 28    | <b>PerfCtrExtL2I: L2I performance counter extensions support.</b><br>Value: 0. Indicates support for <a href="#">MSRC001_023</a> [6,4,2,0] and <a href="#">MSRC001_023</a> [7,5,3,1].           |
| 27    | <b>PerfTsc: performance time-stamp counter supported.</b><br>Value: 1. Indicates support for <a href="#">MSRC001_0280</a> [Performance Time Stamp Counter (CU_PTSC)].                           |
| 26    | <b>DataBreakpointExtension.</b> Value: 1. Indicates data breakpoint support for <a href="#">MSRC001_1027</a> and <a href="#">MSRC001_101</a> [B:9].                                             |
| 25    | Reserved.                                                                                                                                                                                       |
| 24    | <b>PerfCtrExtNB: NB performance counter extensions support.</b> Value: 1. Indicates support for <a href="#">MSRC001_024</a> [6,4,2,0] and <a href="#">MSRC001_024</a> [7,5,3,1].                |
| 23    | <b>PerfCtrExtCore: core performance counter extensions support.</b><br>Value: 1. Indicates support for <a href="#">MSRC001_020</a> [A,8,6,4,2,0] and <a href="#">MSRC001_020</a> [B,9,7,5,3,1]. |
| 22    | <b>TopologyExtensions: topology extensions support.</b> Value: 1. Indicates support for <a href="#">CPUID Fn8000_001D_EAX_x0</a> - <a href="#">CPUID Fn8000_001E_EDX</a> .                      |
| 21    | <b>TBM: trailing bit manipulation instruction support.</b><br>Value: 1.                                                                                                                         |
| 20    | Reserved.                                                                                                                                                                                       |
| 19    | Reserved.                                                                                                                                                                                       |
| 18    | Reserved.                                                                                                                                                                                       |

|    |                                                                                                                                                                                            |
|----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 17 | <b>TCE: translation cache extension.</b><br>Value: 1.                                                                                                                                      |
| 16 | <b>FMA4: 4-operand FMA instruction support.</b><br>Value: 1.                                                                                                                               |
| 15 | <b>LWP: lightweight profiling support.</b><br>Value: 1.                                                                                                                                    |
| 14 | Reserved.                                                                                                                                                                                  |
| 13 | <b>WDT: watchdog timer support.</b> Value: 1.                                                                                                                                              |
| 12 | <b>SKINIT: SKINIT and STGI support.</b> Value: 1.                                                                                                                                          |
| 11 | <b>XOP: extended operation support.</b><br>Value: 1.                                                                                                                                       |
| 10 | <b>IBS: Instruction Based Sampling.</b> Value: 1.                                                                                                                                          |
| 9  | <b>OSVW: OS Visible Work-around support.</b> Value: 1.                                                                                                                                     |
| 8  | <b>3DNowPrefetch: Prefetch and PrefetchW instructions.</b><br>Value: 1.                                                                                                                    |
| 7  | <b>MisAlignSse: Misaligned SSE Mode.</b> Value: 1.                                                                                                                                         |
| 6  | <b>SSE4A: EXTRQ, INSERTQ, MOVNTSS, and MOVNTSD instruction support.</b> Value: 1.                                                                                                          |
| 5  | <b>ABM: advanced bit manipulation.</b> Value: 1. LZCNT instruction support.                                                                                                                |
| 4  | <b>AltMovCr8: LOCK MOV CR0 means MOV CR8.</b> Value: 1.                                                                                                                                    |
| 3  | <b>ExtApicSpace: extended APIC register space.</b> Value: 1.                                                                                                                               |
| 2  | <b>SVM: Secure Virtual Mode feature.</b> Value: Product-specific. Indicates support for: VMRUN, VMLOAD, VMSAVE, CLGI, VMMCALL, and INVLPGA.                                                |
| 1  | <b>CmpLegacy: core multi-processing legacy mode.</b> Value: Product-specific. 1=Multi core product (CUID Fn8000_0008_ECX[NC] != 0). 0=Single core product (CUID Fn8000_0008_ECX[NC] == 0). |
| 0  | <b>LahfSahf: LAHF/SAHF instructions.</b> Value: 1.                                                                                                                                         |

### CUID Fn8000\_0001\_EDX Feature Identifiers

These values can be over-written by [MSRC001\\_1005](#).

| Bits | Description                                                        |
|------|--------------------------------------------------------------------|
| 31   | <b>3DNow: 3DNow!™ instructions.</b> Value: 0.                      |
| 30   | <b>3DNowExt: AMD extensions to 3DNow!™ instructions.</b> Value: 0. |
| 29   | <b>LM: long mode.</b><br>Value: 1.                                 |
| 28   | Reserved.                                                          |
| 27   | <b>RDTSCP: RDTSCP instruction.</b> Value: 1.                       |

|       |                                                                                                                                     |
|-------|-------------------------------------------------------------------------------------------------------------------------------------|
| 26    | <b>Page1GB: one GB large page support.</b> Value: 1.                                                                                |
| 25    | <b>FFXSR: FXSAVE and FXRSTOR instruction optimizations.</b> Value: 1.                                                               |
| 24    | <b>FXSR: FXSAVE and FXRSTOR instructions.</b> Value: 1.                                                                             |
| 23    | <b>MMX: MMX™ instructions.</b> Value: 1.                                                                                            |
| 22    | <b>MmxExt: AMD extensions to MMX instructions.</b> Value: 1.                                                                        |
| 21    | Reserved.                                                                                                                           |
| 20    | <b>NX: no-execute page protection.</b> Value: 1.                                                                                    |
| 19:18 | Reserved.                                                                                                                           |
| 17    | <b>PSE36: page-size extensions.</b> Value: 1.                                                                                       |
| 16    | <b>PAT: page attribute table.</b> Value: 1.                                                                                         |
| 15    | <b>CMOV: conditional move instructions, CMOV, FCOMI, FCMOV.</b> Value: 1.                                                           |
| 14    | <b>MCA: machine check architecture, MCG_CAP.</b> Value: 1.                                                                          |
| 13    | <b>PGE: page global extension, CR4.PGE.</b> Value: 1.                                                                               |
| 12    | <b>MTRR: memory-type range registers.</b> Value: 1.                                                                                 |
| 11    | <b>SysCallSysRet: SYSCALL and SYSRET instructions.</b> Value: 1.                                                                    |
| 10    | Reserved.                                                                                                                           |
| 9     | <b>APIC: advanced programmable interrupt controller (APIC) exists and is enabled.</b> Value: <a href="#">MSR0000_001B</a> [ApicEn]. |
| 8     | <b>CMPXCHG8B: CMPXCHG8B instruction.</b> Value: 1.                                                                                  |
| 7     | <b>MCE: machine check exception, CR4.MCE.</b> Value: 1.                                                                             |
| 6     | <b>PAE: physical-address extensions (PAE).</b> Value: 1.                                                                            |
| 5     | <b>MSR: model-specific registers (MSRs), with RDMSR and WRMSR instructions.</b> Value: 1.                                           |
| 4     | <b>TSC: time stamp counter, RDTSC/RDTSCP instructions, CR4.TSD.</b> Value: 1.                                                       |
| 3     | <b>PSE: page-size extensions (4 MB pages).</b> Value: 1.                                                                            |
| 2     | <b>DE: debugging extensions, IO breakpoints, CR4.DE.</b> Value: 1.                                                                  |
| 1     | <b>VME: virtual-mode enhancements.</b> Value: 1.                                                                                    |
| 0     | <b>FPU: x87 floating point unit on-chip.</b> Value: 1.                                                                              |

### **CPUID Fn8000\_000[4:2]\_E[D,C,B,A]X Processor Name String Identifier**

Table 213: [Valid Values](#) for [CPUID Fn8000\\_000\[4:2\]\\_E\[D,C,B,A\]X](#)

| Register              | Value               |
|-----------------------|---------------------|
| CPUID Fn8000_0002_EAX | MSRC001_0030[31:0]  |
| CPUID Fn8000_0002_EBX | MSRC001_0030[63:32] |
| CPUID Fn8000_0002_ECX | MSRC001_0031[31:0]  |
| CPUID Fn8000_0002_EDX | MSRC001_0031[63:32] |
| CPUID Fn8000_0003_EAX | MSRC001_0032[31:0]  |
| CPUID Fn8000_0003_EBX | MSRC001_0032[63:32] |
| CPUID Fn8000_0003_ECX | MSRC001_0033[31:0]  |
| CPUID Fn8000_0003_EDX | MSRC001_0033[63:32] |

Table 213: [Valid Values](#) for [CPUID Fn8000\\_000\[4:2\]\\_E\[D,C,B,A\]X](#)

|                       |                     |
|-----------------------|---------------------|
| CPUID Fn8000_0004_EAX | MSRC001_0034[31:0]  |
| CPUID Fn8000_0004_EBX | MSRC001_0034[63:32] |
| CPUID Fn8000_0004_ECX | MSRC001_0035[31:0]  |
| CPUID Fn8000_0004_EDX | MSRC001_0035[63:32] |

| Bits | Description                                                                                                                                                                                |
|------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:0 | <b>ProcName: processor name.</b> These return the ASCII string corresponding to the processor name, stored in <a href="#">MSRC001_00[35:30]</a> [ <a href="#">Processor Name String</a> ]. |

**CPUID Fn8000\_0005\_EAX L1 TLB 2M/4M Identifiers**

This function provides the processor's first level cache and TLB characteristics for each core.

| Bits  | Description                                                                                                                                                                                                                                                                                                           |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:24 | <b>L1DTlb2and4MAssoc: data TLB associativity for 2 MB and 4 MB pages.</b> Value: FFh. See: <a href="#">CPUID Fn8000_0005_ECX</a> [L1DcAssoc].                                                                                                                                                                         |
| 23:16 | <b>L1DTlb2and4MSize: data TLB number of entries for 2 MB and 4 MB pages.</b><br>Value: 64.<br>The value returned is for the number of entries available for the 2 MB page size; 4 MB pages require two 2 MB entries, so the number of entries available for the 4 MB page size is one-half the returned value.        |
| 15:8  | <b>L1ITlb2and4MAssoc: instruction TLB associativity for 2 MB and 4 MB pages.</b> Value: FFh. See: <a href="#">CPUID Fn8000_0005_ECX</a> [L1DcAssoc].                                                                                                                                                                  |
| 7:0   | <b>L1ITlb2and4MSize: instruction TLB number of entries for 2 MB and 4 MB pages.</b><br>Value: 24.<br>The value returned is for the number of entries available for the 2 MB page size; 4 MB pages require two 2 MB entries, so the number of entries available for the 4 MB page size is one-half the returned value. |

**CPUID Fn8000\_0005\_EBX L1 TLB 4K Identifiers**

See: [CPUID Fn8000\\_0005\\_EAX](#).

| Bits  | Description                                                                                                                                                                                   |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:24 | <b>L1DTlb4KAssoc: data TLB associativity for 4 KB pages.</b> Value: FFh. See: <a href="#">CPUID Fn8000_0005_ECX</a> [L1DcAssoc].                                                              |
| 23:16 | <b>L1DTlb4KSize: data TLB number of entries for 4 KB pages.</b><br>Value: 64.                                                                                                                 |
| 15:8  | <b>L1ITlb4KAssoc: instruction TLB associativity for 4 KB pages.</b><br>Value: FFh.<br>ITLB associativity for 4 KB pages is reported by <a href="#">CPUID Fn8000_0006_EBX</a> [L2ITlb4KAssoc]. |
| 7:0   | <b>L1ITlb4KSize: instruction TLB number of entries for 4 KB pages.</b><br>Value: 48.<br>ITLB size for 4 KB pages is reported by <a href="#">CPUID Fn8000_0006_EBX</a> [L2ITlb4KSize].         |

**CPUID Fn8000\_0005\_ECX L1 Data Cache Identifiers**

This function provides first level cache characteristics for each core.

| Bits    | Description                                                                                                                                                                                                                                                                                                                                                                                            |      |             |     |          |     |                       |     |       |     |       |         |                 |     |                   |
|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|-----|----------|-----|-----------------------|-----|-------|-----|-------|---------|-----------------|-----|-------------------|
| 31:24   | <b>L1DcSize: L1 data cache size in KB.</b><br>Value: 16.                                                                                                                                                                                                                                                                                                                                               |      |             |     |          |     |                       |     |       |     |       |         |                 |     |                   |
| 23:16   | <b>L1DcAssoc: L1 data cache associativity.</b><br>Value: 4.<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00h</td><td>Reserved</td></tr> <tr> <td>01h</td><td>1 way (direct mapped)</td></tr> <tr> <td>02h</td><td>2 way</td></tr> <tr> <td>03h</td><td>3 way</td></tr> <tr> <td>FEh-04h</td><td>[L1DcAssoc] way</td></tr> <tr> <td>FFh</td><td>Fully associative</td></tr> </table> | Bits | Description | 00h | Reserved | 01h | 1 way (direct mapped) | 02h | 2 way | 03h | 3 way | FEh-04h | [L1DcAssoc] way | FFh | Fully associative |
| Bits    | Description                                                                                                                                                                                                                                                                                                                                                                                            |      |             |     |          |     |                       |     |       |     |       |         |                 |     |                   |
| 00h     | Reserved                                                                                                                                                                                                                                                                                                                                                                                               |      |             |     |          |     |                       |     |       |     |       |         |                 |     |                   |
| 01h     | 1 way (direct mapped)                                                                                                                                                                                                                                                                                                                                                                                  |      |             |     |          |     |                       |     |       |     |       |         |                 |     |                   |
| 02h     | 2 way                                                                                                                                                                                                                                                                                                                                                                                                  |      |             |     |          |     |                       |     |       |     |       |         |                 |     |                   |
| 03h     | 3 way                                                                                                                                                                                                                                                                                                                                                                                                  |      |             |     |          |     |                       |     |       |     |       |         |                 |     |                   |
| FEh-04h | [L1DcAssoc] way                                                                                                                                                                                                                                                                                                                                                                                        |      |             |     |          |     |                       |     |       |     |       |         |                 |     |                   |
| FFh     | Fully associative                                                                                                                                                                                                                                                                                                                                                                                      |      |             |     |          |     |                       |     |       |     |       |         |                 |     |                   |
| 15:8    | <b>L1DcLinesPerTag: L1 data cache lines per tag.</b> Value: 1.                                                                                                                                                                                                                                                                                                                                         |      |             |     |          |     |                       |     |       |     |       |         |                 |     |                   |
| 7:0     | <b>L1DcLineSize: L1 data cache line size in bytes.</b> Value: 64.                                                                                                                                                                                                                                                                                                                                      |      |             |     |          |     |                       |     |       |     |       |         |                 |     |                   |

**CPUID Fn8000\_0005\_EDX L1 Instruction Cache Identifiers**

This function provides first level cache characteristics for each core.

| Bits  | Description                                                                                                                   |
|-------|-------------------------------------------------------------------------------------------------------------------------------|
| 31:24 | <b>L1IcSize: L1 instruction cache size KB.</b><br>Value: 96.                                                                  |
| 23:16 | <b>L1IcAssoc: L1 instruction cache associativity.</b><br>Value: 3.<br>See: <a href="#">CPUID Fn8000_0005_ECX</a> [L1DcAssoc]. |
| 15:8  | <b>L1IcLinesPerTag: L1 instruction cache lines per tag.</b> Value: 1.                                                         |
| 7:0   | <b>L1IcLineSize: L1 instruction cache line size in bytes.</b> Value: 64.                                                      |

**CPUID Fn8000\_0006\_EAX L2 TLB 2M/4M Identifiers**

This function provides the processor's second level cache and TLB characteristics for each core.

| Bits  | Description                                                                                                                                                                                                                                                                                                         |
|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:28 | <b>L2DTlb2and4MAssoc: L2 data TLB associativity for 2 MB and 4 MB pages.</b><br>Value: 6.<br>See: <a href="#">CPUID Fn8000_0006_ECX</a> [L2Assoc].                                                                                                                                                                  |
| 27:16 | <b>L2DTlb2and4MSize: L2 data TLB number of entries for 2 MB and 4 MB pages.</b><br>Value: 1024.<br>The value returned is for the number of entries available for the 2 MB page size; 4 MB pages require two 2 MB entries, so the number of entries available for the 4 MB page size is one-half the returned value. |



|       |                                                                                                                                                                                                                                                                                                                            |
|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 15:12 | <b>L2ITlb2and4MAssoc: L2 instruction TLB associativity for 2 MB and 4 MB pages.</b><br>Value: 6.<br>See: <a href="#">CPUID Fn8000_0006_ECX[L2Assoc]</a> .                                                                                                                                                                  |
| 11:0  | <b>L2ITlb2and4MSize: L2 instruction TLB number of entries for 2 MB and 4 MB pages.</b><br>Value: 1024.<br>The value returned is for the number of entries available for the 2 MB page size; 4 MB pages require two 2 MB entries, so the number of entries available for the 4 MB page size is one-half the returned value. |

### **CPUID Fn8000\_0006\_EBX L2 TLB 4K Identifiers**

This function provides second level TLB characteristics for 4K pages shared by each core on a Compute Unit.

| Bits  | Description                                                                                                                            |
|-------|----------------------------------------------------------------------------------------------------------------------------------------|
| 31:28 | <b>L2DTlb4KAssoc: L2 data TLB associativity for 4 KB pages.</b><br>Value: 6.<br>See: <a href="#">CPUID Fn8000_0006_ECX[L2Assoc]</a> .  |
| 27:16 | <b>L2DTlb4KSize: L2 data TLB number of entries for 4 KB pages.</b><br>Value: 1024.                                                     |
| 15:12 | <b>L2ITlb4KAssoc: L2 instruction TLB associativity for 4 KB pages.</b> Value: 4. See: <a href="#">CPUID Fn8000_0006_ECX[L2Assoc]</a> . |
| 11:0  | <b>L2ITlb4KSize: L2 instruction TLB number of entries for 4 KB pages.</b> Value: 512.                                                  |

### **CPUID Fn8000\_0006\_ECX L2 Cache Identifiers**

| Bits  | Description                                                     |                       |             |                    |
|-------|-----------------------------------------------------------------|-----------------------|-------------|--------------------|
| 31:16 | <b>L2Size: L2 cache size in KB.</b><br>Value: Product-specific. |                       |             |                    |
|       | <u>Bits</u>                                                     | <u>Description</u>    |             |                    |
|       | 03FFh-0000h                                                     | Reserved              |             |                    |
|       | 0400h                                                           | 1 MB                  |             |                    |
|       | 07FFh-0401h                                                     | Reserved              |             |                    |
|       | 0800h                                                           | 2 MB                  |             |                    |
|       | FFFFh-0801h                                                     | Reserved              |             |                    |
|       |                                                                 |                       |             |                    |
| 15:12 | <b>L2Assoc: L2 cache associativity.</b> Value: 8.               |                       |             |                    |
|       | <u>Bits</u>                                                     | <u>Description</u>    | <u>Bits</u> | <u>Description</u> |
|       | 0h                                                              | Disabled.             | 8h          | 16 ways            |
|       | 1h                                                              | 1 way (direct mapped) | 9h          | Reserved           |
|       | 2h                                                              | 2 ways                | Ah          | 32 ways            |
|       | 3h                                                              | Reserved              | Bh          | 48 ways            |
|       | 4h                                                              | 4 ways                | Ch          | 64 ways            |
|       | 5h                                                              | Reserved              | Dh          | 96 ways            |
|       | 6h                                                              | 8 ways                | Eh          | 128 ways           |
|       | 7h                                                              | Reserved              | Fh          | Fully associative  |

|      |                                                            |
|------|------------------------------------------------------------|
| 11:8 | <b>L2LinesPerTag: L2 cache lines per tag.</b> Value: 1.    |
| 7:0  | <b>L2LineSize: L2 cache line size in bytes.</b> Value: 64. |

### CPUID Fn8000\_0006\_EDX L3 Cache Identifiers

This function provides third level cache characteristics shared by all cores.

| Bits  | Description                                               |
|-------|-----------------------------------------------------------|
| 31:18 | <b>L3Size: L3 cache size.</b> Value: 0.                   |
| 17:16 | Reserved.                                                 |
| 15:12 | <b>L3Assoc: L3 cache associativity.</b> Value: 0.         |
| 11:8  | <b>L3LinesPerTag: L3 cache lines per tag.</b> Value: 0.   |
| 7:0   | <b>L3LineSize: L3 cache line size in bytes.</b> Value: 0. |

### CPUID Fn8000\_0007\_EAX Processor Feedback Capabilities

| Bits  | Description                                                                                                                                                                                                                            |
|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:16 | <b>MaxWrapTime.</b> Value: 0000h. Specifies the maximum time between reads that software should use to avoid two wraps. A read of at least once every MaxWrapTime seconds will result in either zero or one wrap during that interval. |
| 15:8  | <b>Version.</b> Value: 00h. Specifies the processor feedback capabilities version.                                                                                                                                                     |
| 7:0   | <b>NumberOfMonitors.</b> Value: 00h. Specifies the number of processor feedback MSR pairs supported. Valid if ( <a href="#">CPUID Fn8000_0007_EDX[ProcFeedbackInterface]</a> ==1).                                                     |

### CPUID Fn8000\_0007\_EBX RAS Capabilities

| Bits | Description                                                                                                                                                                                                                                                                                                            |
|------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:3 | Reserved.                                                                                                                                                                                                                                                                                                              |
| 2    | <b>HWA: hardware assert supported.</b> 1=Indicates support for MSRC001_10[DF:C0]. Value: 0.                                                                                                                                                                                                                            |
| 1    | <b>SUCCOR: Software uncorrectable error containment and recovery capability.</b> Value: 0.                                                                                                                                                                                                                             |
| 0    | <b>McaOverflowRecov: MCA overflow recovery support.</b> Value: 1. 1=MCA overflow conditions (MCi_STATUS[Overflow]=1) are not fatal; software may safely ignore such conditions. 0=MCA overflow conditions require software to shut down the system. See <a href="#">2.15.1.6 [Handling Machine Check Exceptions]</a> . |

**CPUID Fn8000\_0007\_ECX Advanced Power Management Information**

| Bits | Description |
|------|-------------|
| 31:0 | Reserved.   |

**CPUID Fn8000\_0007\_EDX Advanced Power Management Information**

This function provides advanced power management feature identifiers.

| Bits  | Description                                                                                                                                                                                                                                                                                            |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:13 | Reserved.                                                                                                                                                                                                                                                                                              |
| 12    | Reserved.                                                                                                                                                                                                                                                                                              |
| 11    | <b>ProcFeedbackInterface: processor feedback interface.</b> Value: 0. 1=Indicates support for processor feedback interface; <a href="#">CPUID Fn8000_0007_EAX</a> .                                                                                                                                    |
| 10    | <b>EffFreqRO: read-only effective frequency interface.</b><br>Value: 1. 1=Indicates presence of <a href="#">MSRC000_00E7 [Read-Only Max Performance Frequency Clock Count (MPerfReadOnly)]</a> and <a href="#">MSRC000_00E8 [Read-Only Actual Performance Frequency Clock Count (APerfReadOnly)]</a> . |
| 9     | <b>CPB: core performance boost.</b> Value: Product-specific. 1= Indicates presence of <a href="#">MSRC001_0015[CpbDis]</a> and support for core performance boost. See <a href="#">2.5.9 [Application Power Management (APM)]</a> .                                                                    |
| 8     | <b>TscInvariant: TSC invariant.</b> Value: 1. The TSC rate is invariant.                                                                                                                                                                                                                               |
| 7     | <b>HwPstate: hardware P-state control.</b> Value: 1. <a href="#">MSRC001_0061 [P-state Current Limit]</a> , <a href="#">MSRC001_0062 [P-state Control]</a> and <a href="#">MSRC001_0063 [P-state Status]</a> exist.                                                                                    |
| 6     | <b>100MHzSteps: 100 MHz multiplier Control.</b> Value: 1.                                                                                                                                                                                                                                              |
| 5     | Reserved.                                                                                                                                                                                                                                                                                              |
| 4     | <b>TM: hardware thermal control (HTC).</b> Value: Product-specific.                                                                                                                                                                                                                                    |
| 3     | <b>TTP: THERMTRIP.</b> Value: 1.                                                                                                                                                                                                                                                                       |
| 2     | <b>VID: Voltage ID control.</b> Value: 0. Function replaced by HwPstate.                                                                                                                                                                                                                               |
| 1     | <b>FID: Frequency ID control.</b> Value: 0. Function replaced by HwPstate.                                                                                                                                                                                                                             |
| 0     | <b>TS: Temperature sensor.</b> Value: 1.                                                                                                                                                                                                                                                               |

**CPUID Fn8000\_0008\_EAX Long Mode Address Size Identifiers**

This provides information about the maximum physical and linear address width supported by the processor.

| Bits  | Description                                                                                                                                              |
|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:24 | Reserved.                                                                                                                                                |
| 23:16 | <b>GuestPhysAddrSize: maximum guest physical byte address size in bits.</b> Value: 0. 0=The maximum guest physical address size defined by PhysAddrSize. |

|      |                                                                                                                             |
|------|-----------------------------------------------------------------------------------------------------------------------------|
| 15:8 | <b>LinAddrSize: Maximum linear byte address size in bits.</b> Value: IF (CPLD Fn8000_0001_EDX[LM]) THEN 30h ELSE 20h ENDIF. |
| 7:0  | <b>PhysAddrSize: Maximum physical byte address size in bits.</b><br>Value: 30h.                                             |

#### CPLD Fn8000\_0008\_EBX Reserved

| Bits | Description |
|------|-------------|
| 31:0 | Reserved.   |

#### CPLD Fn8000\_0008\_ECX Size Identifiers

This provides information about the number of cores supported by the processor.

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                          |      |             |     |         |     |         |     |         |     |         |
|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|-----|---------|-----|---------|-----|---------|-----|---------|
| 31:18 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                            |      |             |     |         |     |         |     |         |     |         |
| 17:16 | <b>PerfTscSize: performance time-stamp counter size.</b> Value: 00b.<br>Indicates the size of MSRC001_0280[PTSC].<br>Valid only when (CPLD Fn8000_0001_ECX[PerfTsc]==1).<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>40 bits</td></tr> <tr> <td>01b</td><td>48 bits</td></tr> <tr> <td>10b</td><td>56 bits</td></tr> <tr> <td>11b</td><td>64 bits</td></tr> </table> | Bits | Description | 00b | 40 bits | 01b | 48 bits | 10b | 56 bits | 11b | 64 bits |
| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                          |      |             |     |         |     |         |     |         |     |         |
| 00b   | 40 bits                                                                                                                                                                                                                                                                                                                                                                                              |      |             |     |         |     |         |     |         |     |         |
| 01b   | 48 bits                                                                                                                                                                                                                                                                                                                                                                                              |      |             |     |         |     |         |     |         |     |         |
| 10b   | 56 bits                                                                                                                                                                                                                                                                                                                                                                                              |      |             |     |         |     |         |     |         |     |         |
| 11b   | 64 bits                                                                                                                                                                                                                                                                                                                                                                                              |      |             |     |         |     |         |     |         |     |         |
| 15:12 | <b>ApicIdCoreIdSize: APIC ID size.</b><br>Value: 4h.<br>The number of bits in the initial APIC20[ApicId] value that indicate core ID within a processor.                                                                                                                                                                                                                                             |      |             |     |         |     |         |     |         |     |         |
| 11:8  | Reserved.                                                                                                                                                                                                                                                                                                                                                                                            |      |             |     |         |     |         |     |         |     |         |
| 7:0   | <b>NC: number of cores - 1.</b> Value: D18F5x84[CmpCap]-COUNT(D18F3x190[DisCore]). The number of cores in the processor is NC+1 (e.g., if NC=0, then there is one core). See 2.4.4 [Processor Cores and Downcoring].                                                                                                                                                                                 |      |             |     |         |     |         |     |         |     |         |

#### CPLD Fn8000\_0008\_EDX Reserved

| Bits | Description |
|------|-------------|
| 31:0 | Reserved.   |

#### CPLD Fn8000\_0009 Reserved

| Bits | Description |
|------|-------------|
| 31:0 | Reserved.   |

**CPUID Fn8000\_000A\_EAX SVM Revision and Feature Identification**

This provides SVM revision. If (CPUID Fn8000\_0001\_ECX[SVM]==0) then CPUID Fn8000\_000A\_EAX is reserved.

| Bits | Description                              |
|------|------------------------------------------|
| 31:8 | Reserved.                                |
| 7:0  | <b>SvmRev: SVM revision.</b> Value: 01h. |

**CPUID Fn8000\_000A\_EBX SVM Revision and Feature Identification**

This provides SVM revision and feature information. If (CPUID Fn8000\_0001\_ECX[SVM]==0) then CPUID Fn8000\_000A\_EBX is reserved.

| Bits | Description                                                                 |
|------|-----------------------------------------------------------------------------|
| 31:0 | <b>NASID: number of address space identifiers (ASID).</b><br>Value: 10000h. |

**CPUID Fn8000\_000A\_ECX SVM Revision and Feature Identification**

| Bits | Description |
|------|-------------|
| 31:0 | Reserved.   |

**CPUID Fn8000\_000A\_EDX SVM Revision and Feature Identification**

This provides SVM feature information. If (CPUID Fn8000\_0001\_ECX[SVM]==0) then CPUID Fn8000\_000A\_EDX is reserved.

| Bits  | Description                                                                                                                  |
|-------|------------------------------------------------------------------------------------------------------------------------------|
| 31:14 | Reserved.                                                                                                                    |
| 13    | Reserved.                                                                                                                    |
| 12    | <b>PauseFilterThreshold: PAUSE filter threshold.</b> Value: 1.                                                               |
| 11    | Reserved.                                                                                                                    |
| 10    | <b>PauseFilter: pause intercept filter.</b> Value: 1.                                                                        |
| 9:8   | Reserved.                                                                                                                    |
| 7     | <b>DecodeAssists: decode assists.</b> Value: 1.                                                                              |
| 6     | <b>FlushByAsid: flush by ASID.</b> Value: 1.                                                                                 |
| 5     | <b>VmcbClean: VMCB clean bits.</b><br>Value: 1.                                                                              |
| 4     | <b>TscRateMsr: MSR based TSC rate control.</b> Value: 1. 1=Indicates support for TSC ratio<br><a href="#">MSRC000_0104</a> . |
| 3     | <b>NRIPS: NRIP Save.</b> Value: 1.                                                                                           |

|   |                                               |
|---|-----------------------------------------------|
| 2 | <b>SVML: SVM lock.</b> Value: 1.              |
| 1 | <b>LbrVirt: LBR virtualization.</b> Value: 1. |
| 0 | <b>NP: nested paging.</b> Value: 1.           |

#### **CPUID Fn8000\_00[18:0B] Reserved**

| Bits | Description |
|------|-------------|
| 31:0 | Reserved.   |

#### **CPUID Fn8000\_0019\_EAX L1 TLB 1G Identifiers**

This function provides first level TLB characteristics for 1G pages shared by each core on a Compute Unit.

| Bits  | Description                                                                                                                                |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------|
| 31:28 | <b>L1DTlb1GAssoc: L1 data TLB associativity for 1 GB pages.</b> See: <a href="#">CPUID Fn8000_0006_ECX</a> [L2Assoc].<br>Value: Fh.        |
| 27:16 | <b>L1DTlb1GSize: L1 data TLB number of entries for 1 GB pages.</b><br>Value: 64.                                                           |
| 15:12 | <b>L1ITlb1GAssoc: L1 instruction TLB associativity for 1 GB pages.</b> See: <a href="#">CPUID Fn8000_0006_ECX</a> [L2Assoc].<br>Value: Fh. |
| 11:0  | <b>L1ITlb1GSize: L1 instruction TLB number of entries for 1 GB pages.</b><br>Value: 24.                                                    |

#### **CPUID Fn8000\_0019\_EBX L2 TLB 1G Identifiers**

This provides 1 GB paging information. The *associativity* fields are defined by [CPUID Fn8000\\_0006\\_EAX](#), [CPUID Fn8000\\_0006\\_EBX](#), [CPUID Fn8000\\_0006\\_ECX](#) and [CPUID Fn8000\\_0006\\_EDX](#).

| Bits  | Description                                                                                                                        |
|-------|------------------------------------------------------------------------------------------------------------------------------------|
| 31:28 | <b>L2DTlb1GAssoc: L2 data TLB associativity for 1 GB pages.</b> See: <a href="#">CPUID Fn8000_0006_ECX</a> [L2Assoc].<br>Value: 6. |
| 27:16 | <b>L2DTlb1GSize: L2 data TLB number of entries for 1 GB pages.</b><br>Value: 1024.                                                 |

|       |                                                                                                                                           |
|-------|-------------------------------------------------------------------------------------------------------------------------------------------|
| 15:12 | <b>L2ITlb1GAssoc:</b> L2 instruction TLB associativity for 1 GB pages. See: <a href="#">CPUID Fn8000_0006_ECX</a> [L2Assoc].<br>Value: 6. |
| 11:0  | <b>L2ITlb1GSize:</b> L2 instruction TLB number of entries for 1 GB pages.<br>Value: 1024.                                                 |

#### **CPUID Fn8000\_0019\_E[D,C]X Reserved**

| Bits | Description |
|------|-------------|
| 31:0 | Reserved.   |

#### **CPUID Fn8000\_001A\_EAX Performance Optimization Identifiers**

This function returns performance related information. For more details on how to use these bits to optimize software, see the optimization guide.

| Bits | Description                |
|------|----------------------------|
| 31:3 | Reserved.                  |
| 2    | <b>FP256.</b><br>Value: 0. |
| 1    | <b>MOVU.</b> Value: 1.     |
| 0    | <b>FP128.</b> Value: 1.    |

#### **CPUID Fn8000\_001A\_E[D,C,B]X Reserved**

| Bits | Description |
|------|-------------|
| 31:0 | Reserved.   |

#### **CPUID Fn8000\_001B\_EAX Instruction Based Sampling Identifiers**

This function returns IBS feature information.

| Bits  | Description                                                                                                                                                         |
|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:11 | Reserved.                                                                                                                                                           |
| 10    | <b>IbsOpData4:</b> IBS op data 4 MSR supported.<br>Value: 0. See MSRC001_103D [IBS Op Data 4 (DC_IBS_DATA2)].                                                       |
| 9     | <b>IbsFetchCtlExtd:</b> IBS fetch control extended MSR supported.<br>Value: 0. 1=Indicates support for MSRC001_103C [IBS Fetch Control Extended (IC_IBS_EXTD_CTL)]. |

|   |                                                                                                                                                                         |
|---|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 8 | <b>OpBrnFuse: fused branch micro-op indication supported.</b> Value: 1. 1=Indicates support for <a href="#">MSRC001_1035</a> [IbsOpBrnFuse].                            |
| 7 | <b>RipInvalidChk: invalid RIP indication supported.</b> Value: 1. 1=Indicates support for <a href="#">MSRC001_1035</a> [IbsRipInvalid].                                 |
| 6 | <b>OpCntExt: IbsOpCurCnt and IbsOpMaxCnt extend by 7 bits.</b> Value: 1. 1=Indicates support for <a href="#">MSRC001_1033</a> [IbsOpCurCnt[26:20], IbsOpMaxCnt[26:20]]. |
| 5 | <b>BrnTrgt: branch target address reporting supported.</b> Value: 1.                                                                                                    |
| 4 | <b>OpCnt: op counting mode supported.</b> Value: 1.                                                                                                                     |
| 3 | <b>RdWrOpCnt: read write of op counter supported.</b> Value: 1.                                                                                                         |
| 2 | <b>OpSam: IBS execution sampling supported.</b> Value: 1.                                                                                                               |
| 1 | <b>FetchSam: IBS fetch sampling supported.</b> Value: 1.                                                                                                                |
| 0 | <b>IBSFFV: IBS feature flags valid.</b> Value: 1.                                                                                                                       |

### CPUID Fn8000\_001B\_E[D,C,B]X Instruction Based Sampling Identifiers

| Bits | Description |
|------|-------------|
| 31:0 | Reserved.   |

### CPUID Fn8000\_001C\_EAX Lightweight Profiling Capabilities 0

This function returns IBS feature information; see the Lightweight Profiling Specification section titled “Detecting LWP”. If ([CPUID Fn8000\\_0001\\_ECX](#)[LWP]==0) then CPUID Fn8000\_001C\_E[D,C,B,A]X is reserved.

| Bits | Description                                                                                                                                                                                |
|------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31   | <b>LwpInt: interrupt on threshold overflow available.</b> Value: <a href="#">MSRC000_0105</a> [LwpInt]. 1=Interrupt on threshold overflow is available.                                    |
| 30   | <b>LwpPTSC: performance time stamp counter in event record is available.</b> Value: <a href="#">MSRC000_0105</a> [LwpPTSC]. 1=Performance time stamp counter in event record is available. |
| 29   | <b>LwpCont: sampling in continuous mode is available.</b> Value: <a href="#">MSRC000_0105</a> [LwpCont]. 1=Sampling in continuous mode is available.                                       |
| 28:7 | Reserved.                                                                                                                                                                                  |
| 6    | <b>LwpRNH: core reference clocks not halted event available.</b> Value: <a href="#">MSRC000_0105</a> [LwpRNH]. 1=Core reference clocks not halted event is available.                      |
| 5    | <b>LwpCNH: core clocks not halted event available.</b> Value: <a href="#">MSRC000_0105</a> [LwpCNH]. 1=Core clocks not halted event is available.                                          |
| 4    | <b>LwpDME: DC miss event available.</b> Value: <a href="#">MSRC000_0105</a> [LwpDME]. 1=DC miss event is available.                                                                        |
| 3    | <b>LwpBRE: branch retired event available.</b> Value: <a href="#">MSRC000_0105</a> [LwpBRE]. 1=Branch retired event is available.                                                          |
| 2    | <b>LwpIRE: instructions retired event available.</b> Value: <a href="#">MSRC000_0105</a> [LwpIRE]. 1=Instructions retired event is available.                                              |



|   |                                                                                                                               |
|---|-------------------------------------------------------------------------------------------------------------------------------|
| 1 | <b>LwpVAL: LWPVAL instruction available.</b> Value: <a href="#">MSRC000_0105</a> [LwpVAL]. 1=LWPVAL instruction is available. |
| 0 | <b>LwpAvail: LWP available.</b> Value: XCR0[62]. 1=LWP is available.                                                          |

### CPUID Fn8000\_001C\_EBX Lightweight Profiling Capabilities 0

See [CPUID Fn8000\\_001C\\_EAX](#).

| Bits  | Description                                                                                                                            |
|-------|----------------------------------------------------------------------------------------------------------------------------------------|
| 31:24 | <b>LwpEventOffset: offset to the EventInterval1 field.</b> Value: 80h. Offset from the start of the LWPCB to the EventInterval1 field. |
| 23:16 | <b>LwpMaxEvents: maximum EventId.</b> Value: 3. Maximum EventId value that is supported.                                               |
| 15:8  | <b>LwpEventSize: event record size.</b> Value: 20h. Size in bytes of an event record in the LWP event ring buffer.                     |
| 7:0   | <b>LwpCbSize: control block size.</b> Value: 13h. Size in quadwords of the LWPCB.                                                      |

### CPUID Fn8000\_001C\_ECX Lightweight Profiling Capabilities 0

See [CPUID Fn8000\\_001C\\_EAX](#).

| Bits  | Description                                                                                                                                                                |
|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31    | <b>LwpCacheLatency: cache latency filtering supported.</b> Value: 0. 1=Cache-related events can be filtered by latency.                                                    |
| 30    | <b>LwpCacheLevels: cache level filtering supported.</b> Value: 0. 1=Cache-related events can be filtered by the cache level that returned the data.                        |
| 29    | <b>LwpIpFiltering: IP filtering supported.</b> Value: 0. 1=IP filtering is supported.                                                                                      |
| 28    | <b>LwpBranchPrediction: branch prediction filtering supported.</b> Value: 0. 1=Branches Retired events can be filtered based on whether the branch was predicted properly. |
| 27:24 | Reserved.                                                                                                                                                                  |
| 23:16 | <b>LwpMinBufferSize: event ring buffer size.</b> Value: 01h. Minimum size of the LWP event ring buffer, in units of 32 event records.                                      |
| 15:9  | <b>LwpVersion: version.</b> Value: 0000001b. Version of LWP implementation.                                                                                                |
| 8:6   | <b>LwpLatencyRnd: amount cache latency is rounded.</b> Value: 0. The amount by which cache latency is rounded.                                                             |
| 5     | <b>LwpDataAddress: data cache miss address valid.</b> Value: 0. 1=Address is valid for cache miss event records.                                                           |
| 4:0   | <b>LwpLatencyMax: latency counter bit size.</b> Value: 0. Size in bits of the cache latency counters.                                                                      |

### CPUID Fn8000\_001C\_EDX Lightweight Profiling Capabilities 0

See [CPUID Fn8000\\_001C\\_EAX](#).

| Bits | Description                                                                                                         |
|------|---------------------------------------------------------------------------------------------------------------------|
| 31   | <b>LwpInt: interrupt on threshold overflow supported.</b> Value: 1. 1=Interrupt on threshold overflow is supported. |

|      |                                                                                                                                                       |
|------|-------------------------------------------------------------------------------------------------------------------------------------------------------|
| 30   | <b>LwpPTSC: performance time stamp counter in event record is available.</b> Value: 1. 1=Performance time stamp counter in event record is supported. |
| 29   | <b>LwpCont: sampling in continuous mode is available.</b> Value: 1. 1=Sampling in continuous mode is supported.                                       |
| 28:7 | Reserved.                                                                                                                                             |
| 6    | <b>LwpRNH: core reference clocks not halted event supported.</b> Value: 0. 1=Core reference clocks not halted event is supported.                     |
| 5    | <b>LwpCNH: core clocks not halted event supported.</b> Value: 0. 1=Core clocks not halted event is supported.                                         |
| 4    | <b>LwpDME: DC miss event supported.</b> Value: 0. 1=DC miss event is supported.                                                                       |
| 3    | <b>LwpBRE: branch retired event supported.</b> Value: 1. 1=Branch retired event is supported.                                                         |
| 2    | <b>LwpIRE: instructions retired event supported.</b> Value: 1. 1=Instructions retired event is supported.                                             |
| 1    | <b>LwpVAL: LWPVAL instruction supported.</b> Value: 1. 1=LWPVAL instruction is supported.                                                             |
| 0    | <b>LwpAvail: lightweight profiling supported.</b> Value: 1. 1=Lightweight profiling is supported.                                                     |

### CPUID Fn8000\_001D\_EAX\_x0 Cache Properties

CPUID Fn8000\_001D\_EAX\_x0 reports topology information for the DC.

If (CPUID Fn8000\_0001\_ECX[TopologyExtensions]==0) then CPUID Fn8000\_001D\_E[D,C,B,A]X is reserved.

Table 214: ECX mapping to Cache Type for CPUID Fn8000\_001D\_E[D,C,B,A]X

| ECX | Cache Type |
|-----|------------|
| 0   | DC         |
| 1   | IC         |
| 2   | L2         |
| 3   | Null       |

| Bits  | Description                                                                                                                                 |
|-------|---------------------------------------------------------------------------------------------------------------------------------------------|
| 31:26 | Reserved.                                                                                                                                   |
| 25:14 | <b>NumSharingCache: number of cores sharing cache.</b> Value: 000h. The number of cores sharing this cache is NumSharingCache+1.            |
| 13:10 | Reserved.                                                                                                                                   |
| 9     | <b>FullyAssociative: fully associative cache.</b> Value: 0. 1=Cache is fully associative.                                                   |
| 8     | <b>SelfInitialization: cache is self-initializing.</b> Value: 1. 1=Cache is self initializing; cache does not need software initialization. |

|     |                                                                          |                       |
|-----|--------------------------------------------------------------------------|-----------------------|
| 7:5 | <b>CacheLevel: cache level.</b> Identifies the cache level. Value: 001b. |                       |
|     | <u>Bits</u>                                                              | <u>Description</u>    |
|     | 000b                                                                     | Reserved.             |
|     | 001b                                                                     | Level 1               |
|     | 010b                                                                     | Level 2               |
|     | 011b                                                                     | Level 3               |
|     | 111b-100b                                                                | Reserved.             |
| 4:0 | <b>CacheType: cache type.</b> Identifies the type of cache. Value: 01h.  |                       |
|     | <u>Bits</u>                                                              | <u>Description</u>    |
|     | 00h                                                                      | Null; no more caches. |
|     | 01h                                                                      | Data cache            |
|     | 02h                                                                      | Instruction cache     |
|     | 03h                                                                      | Unified cache         |
|     | 1Fh-04h                                                                  | Reserved.             |

### CPUID Fn8000\_001D\_EAX\_x1 Cache Properties

CPUID Fn8000\_001D\_EAX\_x1 reports topology information for the IC. See [CPUID Fn8000\\_001D\\_EAX\\_x0](#).

| Bits  | Description                                                                                                                                                                                            |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:26 | Reserved.                                                                                                                                                                                              |
| 25:14 | <b>NumSharingCache: number of cores sharing cache.</b> See: <a href="#">CPUID Fn8000_001D_EAX_x0</a> [NumSharingCache].<br>Value: IF ( <a href="#">DualCoreEnabled</a> ==1) THEN 001h ELSE 000h ENDIF. |
| 13:10 | Reserved.                                                                                                                                                                                              |
| 9     | <b>FullyAssociative: fully associative cache.</b> Value: 0. See: <a href="#">CPUID Fn8000_001D_EAX_x0</a> [FullyAssociative].                                                                          |
| 8     | <b>SelfInitialization: cache is self-initializing.</b> Value: 1. See: <a href="#">CPUID Fn8000_001D_EAX_x0</a> [SelfInitialization].                                                                   |
| 7:5   | <b>CacheLevel: cache level.</b> Identifies the cache level. Value: 001b. See: <a href="#">CPUID Fn8000_001D_EAX_x0</a> [CacheLevel].                                                                   |
| 4:0   | <b>CacheType: cache type.</b> Value: 02h. See: <a href="#">CPUID Fn8000_001D_EAX_x0</a> [CacheType].                                                                                                   |

### CPUID Fn8000\_001D\_EAX\_x2 Cache Properties

CPUID Fn8000\_001D\_EAX\_x2 reports topology information for the L2. See [CPUID Fn8000\\_001D\\_EAX\\_x0](#).

| Bits  | Description                                                                                                                                                                                            |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:26 | Reserved.                                                                                                                                                                                              |
| 25:14 | <b>NumSharingCache: number of cores sharing cache.</b> See: <a href="#">CPUID Fn8000_001D_EAX_x0</a> [NumSharingCache].<br>Value: IF ( <a href="#">DualCoreEnabled</a> ==1) THEN 001h ELSE 000h ENDIF. |
| 13:10 | Reserved.                                                                                                                                                                                              |

|     |                                                                                                                                      |
|-----|--------------------------------------------------------------------------------------------------------------------------------------|
| 9   | <b>FullyAssociative: fully associative cache.</b> Value: 0. See: <a href="#">CPUID Fn8000_001D_EAX_x0[FullyAssociative]</a> .        |
| 8   | <b>SelfInitialization: cache is self-initializing.</b> Value: 1. See: <a href="#">CPUID Fn8000_001D_EAX_x0[SelfInitialization]</a> . |
| 7:5 | <b>CacheLevel: cache level.</b> Identifies the cache level. Value: 010b. See: <a href="#">CPUID Fn8000_001D_EAX_x0[CacheLevel]</a> . |
| 4:0 | <b>CacheType: cache type.</b> Value: 03h. See: <a href="#">CPUID Fn8000_001D_EAX_x0[CacheType]</a> .                                 |

### **CPUID Fn8000\_001D\_EAX\_x3 Cache Properties**

[CPUID Fn8000\\_001D\\_EAX\\_x3](#) reports done/null. See [CPUID Fn8000\\_001D\\_EAX\\_x0](#).

| Bits | Description                                                                                          |
|------|------------------------------------------------------------------------------------------------------|
| 31:5 | Reserved.                                                                                            |
| 4:0  | <b>CacheType: cache type.</b> Value: 00h. See: <a href="#">CPUID Fn8000_001D_EAX_x0[CacheType]</a> . |

### **CPUID Fn8000\_001D\_EBX\_x0 Cache Properties**

[CPUID Fn8000\\_001D\\_EBX\\_x0](#) reports topology information for the DC. See [CPUID Fn8000\\_001D\\_EAX\\_x0](#).

| Bits  | Description                                                                                                         |
|-------|---------------------------------------------------------------------------------------------------------------------|
| 31:22 | <b>CacheNumWays: cache number of ways.</b> Cache number of ways is CacheNumWays+1. Value: 003h.                     |
| 21:12 | <b>CachePhysPartitions: cache physical line partitions.</b> Value: 000h. Cache partitions is CachePhysPartitions+1. |
| 11:0  | <b>CacheLineSize: cache line size in bytes.</b> Value: 03Fh. Cache line size in bytes is CacheLineSize+1.           |

### **CPUID Fn8000\_001D\_EBX\_x1 Cache Properties**

[CPUID Fn8000\\_001D\\_EBX\\_x1](#) reports topology information for the IC. See [CPUID Fn8000\\_001D\\_EAX\\_x0](#).

| Bits  | Description                                                                                                                                   |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------|
| 31:22 | <b>CacheNumWays: cache number of ways.</b> See: <a href="#">CPUID Fn8000_001D_EBX_x0[CacheNumWays]</a> . Value: 002h.                         |
| 21:12 | <b>CachePhysPartitions: cache physical line partitions.</b> Value: 000h. See: <a href="#">CPUID Fn8000_001D_EBX_x0[CachePhysPartitions]</a> . |
| 11:0  | <b>CacheLineSize: cache line size in bytes.</b> Value: 03Fh. See: <a href="#">CPUID Fn8000_001D_EBX_x0[CacheLineSize]</a> .                   |

### **CPUID Fn8000\_001D\_EBX\_x2 Cache Properties**

[CPUID Fn8000\\_001D\\_EBX\\_x2](#) reports topology information for the L2. See [CPUID Fn8000\\_001D\\_EAX\\_x0](#).

| Bits  | Description                                                                                                                                   |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------|
| 31:22 | <b>CacheNumWays: cache number of ways.</b> Value: 00Fh. See: <a href="#">CPUID Fn8000_001D_EBX_x0</a> [CacheNumWays].                         |
| 21:12 | <b>CachePhysPartitions: cache physical line partitions.</b> Value: 000h. See: <a href="#">CPUID Fn8000_001D_EBX_x0</a> [CachePhysPartitions]. |
| 11:0  | <b>CacheLineSize: cache line size in bytes.</b> Value: 03Fh. See: <a href="#">CPUID Fn8000_001D_EBX_x0</a> [CacheLineSize].                   |

### **CPUID Fn8000\_001D\_EBX\_x3 Cache Properties**

[CPUID Fn8000\\_001D\\_EAX\\_x3](#) reports done/null. See [CPUID Fn8000\\_001D\\_EAX\\_x0](#).

| Bits  | Description                                                                                                                                         |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:22 | <b>CacheNumWays: cache number of ways.</b><br>Value: 0.<br>See: <a href="#">CPUID Fn8000_001D_EBX_x0</a> [CacheNumWays].                            |
| 21:12 | <b>CachePhysPartitions: cache physical line partitions.</b><br>Value: 000h.<br>See: <a href="#">CPUID Fn8000_001D_EBX_x0</a> [CachePhysPartitions]. |
| 11:0  | <b>CacheLineSize: cache line size in bytes.</b><br>Value: 0.<br>See: <a href="#">CPUID Fn8000_001D_EBX_x0</a> [CacheLineSize].                      |

### **CPUID Fn8000\_001D\_ECX\_x0 Cache Properties**

[CPUID Fn8000\\_001D\\_ECX\\_x0](#) reports topology information for the DC. See [CPUID Fn8000\\_001D\\_EAX\\_x0](#).

| Bits | Description                                                                                              |
|------|----------------------------------------------------------------------------------------------------------|
| 31:0 | <b>CacheNumSets: cache number of sets.</b> Cache number of sets is CacheNumSets+1.<br>Value: 0000_003Fh. |

### **CPUID Fn8000\_001D\_ECX\_x1 Cache Properties**

[CPUID Fn8000\\_001D\\_ECX\\_x1](#) reports topology information for the IC. See [CPUID Fn8000\\_001D\\_EAX\\_x0](#).

| Bits | Description                                                                                                                    |
|------|--------------------------------------------------------------------------------------------------------------------------------|
| 31:0 | <b>CacheNumSets: cache number of sets.</b> See: <a href="#">CPUID Fn8000_001D_ECX_x0</a> [CacheNumSets].<br>Value: 0000_01FFh. |

**CPUID Fn8000\_001D\_ECX\_x2 Cache Properties**

CPUID Fn8000\_001D\_ECX\_x2 reports topology information for the L2. See CPUID Fn8000\_001D\_EAX\_x0.

| Bits | Description                                                                                                      |
|------|------------------------------------------------------------------------------------------------------------------|
| 31:0 | <b>CacheNumSets: cache number of sets.</b> Value: Product-specific. See: CPUID Fn8000_001D_ECX_x0[CacheNumSets]. |

**CPUID Fn8000\_001D\_ECX\_x3 Cache Properties**

CPUID Fn8000\_001D\_EAX\_x3 reports done/null. See CPUID Fn8000\_001D\_EAX\_x0.

| Bits | Description                  |
|------|------------------------------|
| 31:0 | Reserved. Value: 0000_0000h. |

**CPUID Fn8000\_001D\_EDX\_x0 Cache Properties**

CPUID Fn8000\_001D\_EDX\_x0 reports topology information for the DC. See CPUID Fn8000\_001D\_EAX\_x0.

| Bits | Description                                                                                                                                                                                                                                                          |
|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:2 | Reserved.                                                                                                                                                                                                                                                            |
| 1    | <b>CacheInclusive: cache inclusive.</b> Value: 0. 0=Cache is not inclusive of lower cache levels. 1=Cache is inclusive of lower cache levels.                                                                                                                        |
| 0    | <b>WBINVD: Write-Back Invalidate/Invalidate.</b> Value: 0. 0=WBINVD/INVD invalidates all lower level caches of non-originating cores sharing this cache. 1=WBINVD/INVD not ensured to invalidate all lower level caches of non-originating cores sharing this cache. |

**CPUID Fn8000\_001D\_EDX\_x1 Cache Properties**

CPUID Fn8000\_001D\_EDX\_x1 reports topology information for the IC. See CPUID Fn8000\_001D\_EAX\_x0.

| Bits | Description                                                                                       |
|------|---------------------------------------------------------------------------------------------------|
| 31:2 | Reserved.                                                                                         |
| 1    | <b>CacheInclusive: cache inclusive.</b> Value: 0. See: CPUID Fn8000_001D_EDX_x0[CacheInclusive].  |
| 0    | <b>WBINVD: Write-Back Invalidate/Invalidate.</b> Value: 0. See: CPUID Fn8000_001D_EDX_x0[WBINVD]. |

**CPUID Fn8000\_001D\_EDX\_x2 Cache Properties**

CPUID Fn8000\_001D\_EDX\_x2 reports topology information for the L2. See CPUID Fn8000\_001D\_EAX\_x0.

| Bits | Description |
|------|-------------|
| 31:2 | Reserved.   |

|   |                                                                                                                    |
|---|--------------------------------------------------------------------------------------------------------------------|
| 1 | <b>CacheInclusive:</b> cache inclusive. See: <a href="#">CPUID Fn8000_001D_EDX_x0[CacheInclusive]</a> . Value: 0.  |
| 0 | <b>WBINVD:</b> Write-Back Invalidate/Invalidate. Value: 1. See: <a href="#">CPUID Fn8000_001D_EDX_x0[WBINVD]</a> . |

### **CPUID Fn8000\_001D\_EDX\_x3 Cache Properties**

[CPUID Fn8000\\_001D\\_EAX\\_x3](#) reports done/null. See [CPUID Fn8000\\_001D\\_EAX\\_x0](#).

| Bits | Description                  |
|------|------------------------------|
| 31:0 | Reserved. Value: 0000_0000h. |

### **CPUID Fn8000\_001E\_EAX Extended APIC ID**

If [CPUID Fn8000\\_0001\\_ECX\[TopologyExtensions\]](#)==0 then [CPUID Fn8000\\_001E\\_E\[D,C,B,A\]X](#) is reserved. If ([MSR0000\\_001B\[ApicEn\]](#)==0) then [CPUID Fn8000\\_001E\\_EAX\[ExtendedApicId\]](#) is reserved.

| Bits | Description                                                                                                                                                |
|------|------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:0 | <b>ExtendedApicId:</b> extended APIC ID.<br>Value: IF ( <a href="#">MSR0000_001B[ApicEn]</a> ==0) THEN 0000_0000h ELSE <a href="#">APIC20[31:0]</a> ENDIF. |

### **CPUID Fn8000\_001E\_EBX Compute Unit Identifiers**

See [CPUID Fn8000\\_001E\\_EAX](#).

| Bits  | Description                                                                                                                                                             |
|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:16 | Reserved.                                                                                                                                                               |
| 15:8  | <b>ThreadsPerComputeUnit:</b> threads per compute unit. The number of threads per compute unit is <a href="#">ThreadsPerComputeUnit</a> +1.<br>Value: Product-specific. |
| 7:0   | <b>ComputeUnitId:</b> compute unit ID. Identifies the processor compute unit ID.<br>Value: Product-specific.                                                            |

### **CPUID Fn8000\_001E\_ECX Node Identifiers**

See [CPUID Fn8000\\_001E\\_EAX](#).

| Bits | Description |
|------|-------------|
| 31:0 | Reserved.   |

### **CPUID Fn8000\_001E\_EDX Reserved**

See [CPUID Fn8000\\_001E\\_EAX](#).

| Bits | Description |
|------|-------------|
| 31:0 | Reserved.   |



### 3.19 MSRs - MSR0000\_XXXX

See 3.1 [Register Descriptions and Mnemonics] for a description of the register naming convention. MSRs are accessed through x86 WRMSR and RDMSR instructions.

#### MSR0000\_0000 Load-Store MCA Address

| Bits | Description                             |
|------|-----------------------------------------|
| 63:0 | Alias of <a href="#">MSR0000_0402</a> . |

#### MSR0000\_0001 Load-Store MCA Status

| Bits | Description                             |
|------|-----------------------------------------|
| 63:0 | Alias of <a href="#">MSR0000_0401</a> . |

#### MSR0000\_0010 Time Stamp Counter (TSC)

Reset: 0000\_0000\_0000\_0000h.

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 63:32 | <b>TSC[63:32]: time stamp counter high.</b> See: TSC[31:0].                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| 31:0  | <b>TSC[31:0]: time stamp counter low.</b> Read-write; updated-by-hardware. TSC[63:0] = {TSC[63:32], TSC[31:0]}. The TSC increments at the P0 frequency. This field uses software P-state numbering. See 2.5.3.1.1.1 [Software P-state Numbering]. The TSC counts at the same rate in all P-states, all C states, S0, or S1. A read of this MSR in guest mode is affected by <a href="#">MSRC000_0104 [Time Stamp Counter Ratio (TscRateMsr)]</a> . The value (TSC/TSCRatio) is the TSC P0 frequency based value (as if TSCRatio==1.0) when (TSCRatio!=1.0). |

#### MSR0000\_001B APIC Base Address (APIC\_BAR)

| Bits  | Description                                                                                                                                                                                                             |
|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 63:40 | MBZ.                                                                                                                                                                                                                    |
| 39:12 | <b>ApicBar[39:12]: APIC base address register.</b> Read-write. Reset: 00_FEE0_0h. Specifies the base address, physical address [39:12], for the APICXX register set in xAPIC mode. See 2.4.9.1.2 [APIC Register Space]. |
| 11    | <b>ApicEn: APIC enable.</b> Read-write. Reset: 0. See 2.4.9.1.2 [APIC Register Space]. 1=Local APIC is enabled in xAPIC mode.                                                                                           |
| 10    | MBZ.                                                                                                                                                                                                                    |
| 9     | MBZ.                                                                                                                                                                                                                    |
| 8     | <b>BSC: boot strap core.</b> Read-write; updated-by-hardware. Reset: x. 1=The core is the boot core of the BSP. 0=The core is not the boot core of the BSP.                                                             |
| 7:0   | MBZ.                                                                                                                                                                                                                    |

**MSR0000\_002A Cluster ID (EBL\_CR\_POWERON)**

Read; GP-write. Writes to this register result in a GP fault with error code 0.

| Bits  | Description                                                        |
|-------|--------------------------------------------------------------------|
| 63:18 | MBZ.                                                               |
| 17:16 | <b>ClusterID</b> . Reset: 00b. The field does not affect hardware. |
| 15:0  | MBZ.                                                               |

**MSR0000\_00E7 Max Performance Frequency Clock Count (MPERF)**

Reset: 0000\_0000\_0000\_0000h.

| Bits | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 63:0 | <b>MPERF: maximum core clocks counter</b> . Read-write; <a href="#">Updated-by-hardware</a> . Incremented by hardware at the P0 frequency while the core is in C0. This register does not increment when the core is in the stop-grant state. In combination with <a href="#">MSR0000_00E8</a> , this is used to determine the effective frequency of the core. A read of this MSR in guest mode is affected by <a href="#">MSRC000_0104 [Time Stamp Counter Ratio (TscRateMsr)]</a> . This field uses software P-state numbering. See <a href="#">MSRC001_0015[Eff-FreqCntMwait]</a> , <a href="#">2.5.3.3 [Effective Frequency]</a> , and <a href="#">2.5.3.1.1.1 [Software P-state Numbering]</a> . |

**MSR0000\_00E8 Actual Performance Frequency Clock Count (APERF)**

Reset: 0000\_0000\_0000\_0000h.

| Bits | Description                                                                                                                                                                                                                                                                                                          |
|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 63:0 | <b>APERF: actual core clocks counter</b> . Read-write; <a href="#">Updated-by-hardware</a> . This register increments in proportion to the actual number of core clocks cycles while the core is in C0. The register does not increment when the core is in the stop-grant state. See <a href="#">MSR0000_00E7</a> . |

**MSR0000\_00FE MTRR Capabilities (MTRRcap)**

Read; GP-write. Reset: 0000\_0000\_0000\_0508h.

| Bits  | Description                                                                                            |
|-------|--------------------------------------------------------------------------------------------------------|
| 63:11 | Reserved.                                                                                              |
| 10    | <b>MtrrCapWc: write-combining memory type</b> . 1=The write combining memory type is supported.        |
| 9     | Reserved.                                                                                              |
| 8     | <b>MtrrCapFix: fixed range register</b> . 1=Fixed MTRRs are supported.                                 |
| 7:0   | <b>MtrrCapVCnt: variable range registers count</b> . Specifies the number of variable MTRRs supported. |

**MSR0000\_0174 SYSENTER CS (SYSENTER\_CS)**

| Bits  | Description |
|-------|-------------|
| 63:32 | RAZ.        |

|       |                                                                                                           |
|-------|-----------------------------------------------------------------------------------------------------------|
| 31:16 | Reserved.                                                                                                 |
| 15:0  | <b>SysEnterCS: SYSENTER target CS.</b> Read-write. Reset: 0000h. Holds the called procedure code segment. |

#### MSR0000\_0175 SYSENTER ESP (SYSENTER\_ESP)

Reset: 0000\_0000\_0000\_0000h.

| Bits  | Description                                                                                   |
|-------|-----------------------------------------------------------------------------------------------|
| 63:32 | Reserved.                                                                                     |
| 31:0  | <b>SysEnterESP: SYSENTER target SP.</b> Read-write. Holds the called procedure stack pointer. |

#### MSR0000\_0176 SYSENTER EIP (SYSENTER\_EIP)

Reset: 0000\_0000\_0000\_0000h.

| Bits  | Description                                                                                         |
|-------|-----------------------------------------------------------------------------------------------------|
| 63:32 | Reserved.                                                                                           |
| 31:0  | <b>SysEnterEIP: SYSENTER target IP.</b> Read-write. Holds the called procedure instruction pointer. |

#### MSR0000\_0179 Global Machine Check Capabilities (MCG\_CAP)

Read; GP-write.

| Bits | Description                                                                                                                                                                                   |
|------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 63:9 | Reserved.                                                                                                                                                                                     |
| 8    | <b>McgCtlP: MCG_CTL register present.</b> Value: 1. 1=The machine check control registers (MCI_CTL) are present. See <a href="#">2.15.1 [Machine Check Architecture]</a>                      |
| 7:0  | <b>Count.</b> Value: 07h. Indicates the number of error reporting banks visible to each core. 06h=Error-reporting banks 0 through 5. See <a href="#">2.15.1.1 [Machine Check Registers]</a> . |

#### MSR0000\_017A Global Machine Check Status (MCG\_STAT)

Reset: 0000\_0000\_0000\_0000h. See [2.15.1 \[Machine Check Architecture\]](#).

| Bits | Description                                                                                                                                                                                                                                                                                                                                                                                                                              |
|------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 63:3 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                |
| 2    | <b>MCIP: machine check in progress.</b> Read-write; set-by-hardware. 1=A machine check is in progress.                                                                                                                                                                                                                                                                                                                                   |
| 1    | <b>EIPV: error instruction pointer valid.</b> Read-write; Updated-by-hardware. 1=The instruction pointer that was pushed onto the stack by the machine check mechanism references the instruction that caused the machine check error.                                                                                                                                                                                                   |
| 0    | <b>RIPV: restart instruction pointer valid.</b> Read-write; Updated-by-hardware. 1=Program execution can be reliably restarted at the EIP address on the stack. 0=The interrupt was not precise and/or the process (task) context may be corrupt; continued operation of this process may not be possible without intervention, however system processing or other processes may be able to continue with appropriate software clean up. |

**MSR0000\_017B Global Machine Check Exception Reporting Control (MCG\_CTL)**

Read-write. Reset: 0000\_0000\_0000\_0000h. This registers controls enablement of the individual error reporting banks; see 2.15.1 [Machine Check Architecture]. When a machine check register bank is not enabled in MCG\_CTL, errors for that bank are not logged or reported, and actions enabled through the MCA are not taken; each MCi\_CTL register identifies which errors are still corrected when MCG\_CTL[i] is disabled.

| Bits | Description                                                                                                         |
|------|---------------------------------------------------------------------------------------------------------------------|
| 63:7 | Unused.                                                                                                             |
| 6    | <b>MC6En: MC6 register bank enable.</b> 1=The MC6 machine check register bank is enabled.                           |
| 5    | <b>MC5En: MC5 register bank enable.</b> 1=The MC5 machine check register bank is enabled.                           |
| 4    | <b>MC4En: MC4 register bank enable.</b> 1=The MC4 machine check register bank is enabled for all cores of the node. |
| 3    | Unused.                                                                                                             |
| 2    | <b>MC2En: MC2 register bank enable.</b> 1=The MC2 machine check register bank is enabled.                           |
| 1    | <b>MC1En: MC1 register bank enable.</b> 1=The MC1 machine check register bank is enabled.                           |
| 0    | <b>MC0En: MC0 register bank enable.</b> 1=The MC0 machine check register bank is enabled.                           |

**MSR0000\_01D9 Debug Control (DBG\_CTL\_MSR)**

| Bits | Description                                                                                                 |
|------|-------------------------------------------------------------------------------------------------------------|
| 63:7 | Reserved.                                                                                                   |
| 6    | MBZ.                                                                                                        |
| 5:2  | <b>PB: performance monitor pin control.</b> Read-write. Reset: 0. This field does not control any hardware. |
| 1    | <b>BTF.</b> Read-write. Reset: 0. 1=Enable branch single step.                                              |
| 0    | <b>LBR.</b> Read-write. Reset: 0. 1=Enable last branch record.                                              |

**MSR0000\_01DB Last Branch From IP (BR\_FROM)**

Read; GP-write; *Not-same-for-all*, *Updated-by-hardware*. Reset: 0000\_0000\_0000\_0000h.

| Bits | Description                                                                        |
|------|------------------------------------------------------------------------------------|
| 63:0 | <b>LastBranchFromIP.</b> Loaded with the segment offset of the branch instruction. |

**MSR0000\_01DC Last Branch To IP (BR\_TO)**

Read; GP-write; *Not-same-for-all*, *Updated-by-hardware*. Reset: 0000\_0000\_0000\_0000h.

| Bits | Description                                                                                                    |
|------|----------------------------------------------------------------------------------------------------------------|
| 63:0 | <b>LastBranchToIP.</b> Holds the target RIP of the last branch that occurred before an exception or interrupt. |

**MSR0000\_01DD Last Exception From IP**

Read; GP-write; [Not-same-for-all](#), [Updated-by-hardware](#). Reset: 0000\_0000\_0000\_0000h.

| Bits | Description                                                                                                     |
|------|-----------------------------------------------------------------------------------------------------------------|
| 63:0 | <b>LastIntFromIP</b> . Holds the source RIP of the last branch that occurred before the exception or interrupt. |

**MSR0000\_01DE Last Exception To IP**

Read; GP-write; [Not-same-for-all](#), [Updated-by-hardware](#). Reset: 0000\_0000\_0000\_0000h.

| Bits | Description                                                                                                   |
|------|---------------------------------------------------------------------------------------------------------------|
| 63:0 | <b>LastIntToIP</b> . Holds the target RIP of the last branch that occurred before the exception or interrupt. |

**MSR0000\_020[F:0] Variable-Size MTRRs Base/Mask**

[Per-compute-unit](#).

Each MTRR ([MSR0000\\_020\[F:0\] \[Variable-Size MTRRs Base/Mask\]](#), [MSR0000\\_02\[6F:68,59:58,50\]](#), or [MSR0000\\_02FF \[MTRR Default Memory Type \(MTRRdefType\)\]](#)) specifies a physical address range and a corresponding memory type (MemType) associated with that range. Setting the memory type to an unsupported value results in a #GP.

The variable-size MTRRs come in pairs of base and mask registers ([MSR0000\\_0200](#) and [MSR0000\\_0201](#) are the first pair, etc.). Variables MTRRs are enabled through [MSR0000\\_02FF\[MtrrDefTypeEn\]](#). A core access--with address CPUAddr--is determined to be within the address range of a variable-size MTRR if the following equation is true:

$\text{CPUAddr}[39:12] \& \text{PhyMask}[39:12] == \text{PhyBase}[39:12] \& \text{PhyMask}[39:12]$ .

For example, if the variable MTRR spans 256 KB and starts at the 1 MB address. The PhyBase would be set to 0\_0010\_0000h and the PhyMask to F\_FFFC\_0000h (with zeros filling in for bits[11:0]). This results in a range from 0\_0010\_0000h to 0\_0013\_FFFF.

**MSR0000\_020[E,C,A,8,6,4,2,0] Variable-Size MTRRs Base**

Table 215: [Register Mapping](#) for [MSR0000\\_020\[E,C,A,8,6,4,2,0\]](#)

| Register     | Function |
|--------------|----------|
| MSR0000_0200 | Range 0  |
| MSR0000_0202 | Range 1  |
| MSR0000_0204 | Range 2  |
| MSR0000_0206 | Range 3  |
| MSR0000_0208 | Range 4  |
| MSR0000_020A | Range 5  |
| MSR0000_020C | Range 6  |
| MSR0000_020E | Range 7  |

**Table 216: Valid Values** for Memory Type Definition

| Bits      | Description            |
|-----------|------------------------|
| 000b      | UC or uncacheable.     |
| 001b      | WC or write combining. |
| 011b-010b | Reserved               |
| 100b      | WT or write through.   |
| 101b      | WP or write protect.   |
| 110b      | WB or write back.      |
| 111b      | Reserved               |

| Bits  | Description                                                                                                                                                        |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 63:48 | MBZ.                                                                                                                                                               |
| 47:12 | <b>PhyBase: base address.</b> Read-write. Reset: 0.                                                                                                                |
| 11:3  | MBZ.                                                                                                                                                               |
| 2:0   | <b>MemType: memory type.</b> Read-write. Reset: 0. Address range from 00000h to 0FFFFh. See: <a href="#">Table 216 [Valid Values for Memory Type Definition]</a> . |

**MSR0000\_020[F,D,B,9,7,5,3,1] Variable-Size MTRRs Mask**Table 217: [Register Mapping](#) for [MSR0000\\_020\[F,D,B,9,7,5,3,1\]](#)

| Register     | Function |
|--------------|----------|
| MSR0000_0201 | Range 0  |
| MSR0000_0203 | Range 1  |
| MSR0000_0205 | Range 2  |
| MSR0000_0207 | Range 3  |
| MSR0000_0209 | Range 4  |
| MSR0000_020B | Range 5  |
| MSR0000_020D | Range 6  |
| MSR0000_020F | Range 7  |

| Bits  | Description                                                                          |
|-------|--------------------------------------------------------------------------------------|
| 63:48 | MBZ.                                                                                 |
| 47:12 | <b>PhyMask: address mask.</b> Read-write. Reset: 0.                                  |
| 11    | <b>Valid: valid.</b> Read-write. Reset: 0. 1=The variable-size MTRR pair is enabled. |
| 10:0  | MBZ.                                                                                 |

**MSR0000\_02[6F:68,59:58,50] Fixed-Size MTRRs**

[Per-compute-unit.](#)

See [MSR0000\\_020\[F:0\]](#) for general MTRR information. Fixed MTRRs are enabled through [MSR0000\\_02FF](#)[MtrrDefTypeFixEn, MtrrDefTypeEn]. For addresses below 1MB, the appropriate Fixed

MTRRs override the default access destination. Each fixed MTRR includes two bits, RdDram and WrDram, that determine the destination based on the access type.

See 2.4.6.1.2 [Determining The Access Destination for Core Accesses].

Table 218: Register Mapping for MSR0000\_02[6F:68,59:58,50]

| Register     | Function    |
|--------------|-------------|
| MSR0000_0250 | 64K Range   |
| MSR0000_0258 | 16K_0 Range |
| MSR0000_0259 | 16K_1 Range |
| MSR0000_0268 | 4K_0 Range  |
| MSR0000_0269 | 4K_1 Range  |
| MSR0000_026A | 4K_2 Range  |
| MSR0000_026B | 4K_3 Range  |
| MSR0000_026C | 4K_4 Range  |
| MSR0000_026D | 4K_5 Range  |
| MSR0000_026E | 4K_6 Range  |
| MSR0000_026F | 4K_7 Range  |

Table 219: Field Mapping for MSR0000\_02[6F:68,59:58,50]

| Register     | Bits      |           |           |           |           |           |           |           |
|--------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
|              | 63:56     | 55:48     | 47:40     | 39:32     | 31:24     | 23:16     | 15:8      | 7:0       |
| MSR0000_0250 | 64K_70000 | 64K_60000 | 64K_50000 | 64K_40000 | 64K_30000 | 64K_20000 | 64K_10000 | 64K_00000 |
| MSR0000_0258 | 16K_9C000 | 16K_98000 | 16K_94000 | 16K_90000 | 16K_8C000 | 16K_88000 | 16K_84000 | 16K_80000 |
| MSR0000_0259 | 16K_BC000 | 16K_B8000 | 16K_B4000 | 16K_B0000 | 16K_AC000 | 16K_A8000 | 16K_A4000 | 16K_A0000 |
| MSR0000_0268 | 4K_C7000  | 4K_C6000  | 4K_C5000  | 4K_C4000  | 4K_C3000  | 4K_C2000  | 4K_C1000  | 4K_C0000  |
| MSR0000_0269 | 4K_CF000  | 4K_CE000  | 4K_CD000  | 4K_CC000  | 4K_CB000  | 4K_CA000  | 4K_C9000  | 4K_C8000  |
| MSR0000_026A | 4K_D7000  | 4K_D6000  | 4K_D5000  | 4K_D4000  | 4K_D3000  | 4K_D2000  | 4K_D1000  | 4K_D0000  |
| MSR0000_026B | 4K_DF000  | 4K_DE000  | 4K_DD000  | 4K_DC000  | 4K_DB000  | 4K_DA000  | 4K_D9000  | 4K_D8000  |
| MSR0000_026C | 4K_E7000  | 4K_E6000  | 4K_E5000  | 4K_E4000  | 4K_E3000  | 4K_E2000  | 4K_E1000  | 4K_E0000  |
| MSR0000_026D | 4K_EF000  | 4K_EE000  | 4K_ED000  | 4K_EC000  | 4K_EB000  | 4K_EA000  | 4K_E9000  | 4K_E8000  |
| MSR0000_026E | 4K_F7000  | 4K_F6000  | 4K_F5000  | 4K_F4000  | 4K_F3000  | 4K_F2000  | 4K_F1000  | 4K_F0000  |
| MSR0000_026F | 4K_FF000  | 4K_FE000  | 4K_FD000  | 4K_FC000  | 4K_FB000  | 4K_FA000  | 4K_F9000  | 4K_F8000  |

| Bits  | Description                                                        |
|-------|--------------------------------------------------------------------|
| 63:61 | MBZ.                                                               |
| 60    | <b>RdDram: read DRAM.</b> See: MSR0000_02[6F:68,59:58,50][4].      |
| 59    | <b>WrDram: write DRAM.</b> See: MSR0000_02[6F:68,59:58,50][3].     |
| 58:56 | <b>MemType: memory type.</b> See: MSR0000_02[6F:68,59:58,50][2:0]. |
| 55:53 | MBZ.                                                               |
| 52    | <b>RdDram: read DRAM.</b> See: MSR0000_02[6F:68,59:58,50][4].      |
| 51    | <b>WrDram: write DRAM.</b> See: MSR0000_02[6F:68,59:58,50][3].     |
| 50:48 | <b>MemType: memory type.</b> See: MSR0000_02[6F:68,59:58,50][2:0]. |

|       |                                                                                                                                                                                                                                                                                                                                                          |
|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 47:45 | MBZ.                                                                                                                                                                                                                                                                                                                                                     |
| 44    | <b>RdDram: read DRAM.</b> See: <a href="#">MSR0000_02[6F:68,59:58,50][4]</a> .                                                                                                                                                                                                                                                                           |
| 43    | <b>WrDram: write DRAM.</b> See: <a href="#">MSR0000_02[6F:68,59:58,50][3]</a> .                                                                                                                                                                                                                                                                          |
| 42:40 | <b>MemType: memory type.</b> See: <a href="#">MSR0000_02[6F:68,59:58,50][2:0]</a> .                                                                                                                                                                                                                                                                      |
| 39:37 | MBZ.                                                                                                                                                                                                                                                                                                                                                     |
| 36    | <b>RdDram: read DRAM.</b> See: <a href="#">MSR0000_02[6F:68,59:58,50][4]</a> .                                                                                                                                                                                                                                                                           |
| 35    | <b>WrDram: write DRAM.</b> See: <a href="#">MSR0000_02[6F:68,59:58,50][3]</a> .                                                                                                                                                                                                                                                                          |
| 34:32 | <b>MemType: memory type.</b> See: <a href="#">MSR0000_02[6F:68,59:58,50][2:0]</a> .                                                                                                                                                                                                                                                                      |
| 31:29 | MBZ.                                                                                                                                                                                                                                                                                                                                                     |
| 28    | <b>RdDram: read DRAM.</b> See: <a href="#">MSR0000_02[6F:68,59:58,50][4]</a> .                                                                                                                                                                                                                                                                           |
| 27    | <b>WrDram: write DRAM.</b> See: <a href="#">MSR0000_02[6F:68,59:58,50][3]</a> .                                                                                                                                                                                                                                                                          |
| 26:24 | <b>MemType: memory type.</b> See: <a href="#">MSR0000_02[6F:68,59:58,50][2:0]</a> .                                                                                                                                                                                                                                                                      |
| 23:21 | MBZ.                                                                                                                                                                                                                                                                                                                                                     |
| 20    | <b>RdDram: read DRAM.</b> See: <a href="#">MSR0000_02[6F:68,59:58,50][4]</a> .                                                                                                                                                                                                                                                                           |
| 19    | <b>WrDram: write DRAM.</b> See: <a href="#">MSR0000_02[6F:68,59:58,50][3]</a> .                                                                                                                                                                                                                                                                          |
| 18:16 | <b>MemType: memory type.</b> See: <a href="#">MSR0000_02[6F:68,59:58,50][2:0]</a> .                                                                                                                                                                                                                                                                      |
| 15:13 | MBZ.                                                                                                                                                                                                                                                                                                                                                     |
| 12    | <b>RdDram: read DRAM.</b> See: <a href="#">MSR0000_02[6F:68,59:58,50][4]</a> .                                                                                                                                                                                                                                                                           |
| 11    | <b>WrDram: write DRAM.</b> See: <a href="#">MSR0000_02[6F:68,59:58,50][3]</a> .                                                                                                                                                                                                                                                                          |
| 10:8  | <b>MemType: memory type.</b> See: <a href="#">MSR0000_02[6F:68,59:58,50][2:0]</a> .                                                                                                                                                                                                                                                                      |
| 7:5   | MBZ.                                                                                                                                                                                                                                                                                                                                                     |
| 4     | <b>RdDram: read DRAM.</b> IF ( <a href="#">MSRC001_0010</a> [MtrrFixDramModEn]) THEN Read-write. ELSE MBZ. ENDIF. Reset: 0. 0=Read accesses to the range are marked as MMIO. 1=Read accesses to the range are marked as destined for DRAM. Address range from 00000h to 0FFFFh. See: <a href="#">MSRC001_0010</a> [MtrrFixDramEn, MtrrFixDramModEn]).    |
| 3     | <b>WrDram: write DRAM.</b> IF ( <a href="#">MSRC001_0010</a> [MtrrFixDramModEn]) THEN Read-write. ELSE MBZ. ENDIF. Reset: 0. 0=Write accesses to the range are marked as MMIO. 1=Write accesses to the range are marked as destined for DRAM. Address range from 00000h to 0FFFFh. See: <a href="#">MSRC001_0010</a> [MtrrFixDramEn, MtrrFixDramModEn]). |
| 2:0   | <b>MemType: memory type.</b> Read-write. Reset: 0. Address range from 00000h to 0FFFFh. See: <a href="#">Table 216 [Valid Values for Memory Type Definition]</a> .                                                                                                                                                                                       |

### MSR0000\_0277 Page Attribute Table (PAT)

This register specifies the memory type based on the PAT, PCD, and PWT bits in the virtual address page tables.

| Bits  | Description                                                                                   |
|-------|-----------------------------------------------------------------------------------------------|
| 63:59 | MBZ.                                                                                          |
| 58:56 | <b>PA7MemType.</b> See: PA0MemType. Reset: 0h. Default UC. MemType for {PAT, PCD, PWT} = 7h.  |
| 55:51 | MBZ.                                                                                          |
| 50:48 | <b>PA6MemType.</b> See: PA0MemType. Reset: 7h. Default UC-. MemType for {PAT, PCD, PWT} = 6h. |



|             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |             |                                              |             |                    |    |                      |  |                      |    |                          |  |                      |    |      |    |                   |    |      |    |                                              |
|-------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|----------------------------------------------|-------------|--------------------|----|----------------------|--|----------------------|----|--------------------------|--|----------------------|----|------|----|-------------------|----|------|----|----------------------------------------------|
| 47:43       | MBZ.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |             |                                              |             |                    |    |                      |  |                      |    |                          |  |                      |    |      |    |                   |    |      |    |                                              |
| 42:40       | <b>PA5MemType</b> . See: PA0MemType. Reset: 4h. Default WT. MemType for {PAT, PCD, PWT} = 5h.                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |             |                                              |             |                    |    |                      |  |                      |    |                          |  |                      |    |      |    |                   |    |      |    |                                              |
| 39:35       | MBZ.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |             |                                              |             |                    |    |                      |  |                      |    |                          |  |                      |    |      |    |                   |    |      |    |                                              |
| 34:32       | <b>PA4MemType</b> . See: PA0MemType. Reset: 6h. Default WB. MemType for {PAT, PCD, PWT} = 4h.                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |             |                                              |             |                    |    |                      |  |                      |    |                          |  |                      |    |      |    |                   |    |      |    |                                              |
| 31:27       | MBZ.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |             |                                              |             |                    |    |                      |  |                      |    |                          |  |                      |    |      |    |                   |    |      |    |                                              |
| 26:24       | <b>PA3MemType</b> . See: PA0MemType. Reset: 0h. Default UC. MemType for {PAT, PCD, PWT} = 3h.                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |             |                                              |             |                    |    |                      |  |                      |    |                          |  |                      |    |      |    |                   |    |      |    |                                              |
| 23:19       | MBZ.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |             |                                              |             |                    |    |                      |  |                      |    |                          |  |                      |    |      |    |                   |    |      |    |                                              |
| 18:16       | <b>PA2MemType</b> . See: PA0MemType. Reset: 7h. Default UC-. MemType for {PAT, PCD, PWT} = 2h.                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |             |                                              |             |                    |    |                      |  |                      |    |                          |  |                      |    |      |    |                   |    |      |    |                                              |
| 15:11       | MBZ.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |             |                                              |             |                    |    |                      |  |                      |    |                          |  |                      |    |      |    |                   |    |      |    |                                              |
| 10:8        | <b>PA1MemType</b> . See: PA0MemType. Reset: 4h. Default WT. MemType for {PAT, PCD, PWT} = 1h.                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |             |                                              |             |                    |    |                      |  |                      |    |                          |  |                      |    |      |    |                   |    |      |    |                                              |
| 7:3         | MBZ.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |             |                                              |             |                    |    |                      |  |                      |    |                          |  |                      |    |      |    |                   |    |      |    |                                              |
| 2:0         | <b>PA0MemType</b> . Read-write. Reset: 6h. MemType for {PAT, PCD, PWT} = 0h.<br><table><tr><td><u>Bits</u></td><td><u>Description</u></td><td><u>Bits</u></td><td><u>Description</u></td></tr><tr><td>0h</td><td>UC or uncacheable.4h</td><td></td><td>WT or write through.</td></tr><tr><td>1h</td><td>WC or write combining.5h</td><td></td><td>WP or write protect.</td></tr><tr><td>2h</td><td>MBZ.</td><td>6h</td><td>WB or write back.</td></tr><tr><td>3h</td><td>MBZ.</td><td>7h</td><td>UC- or uncacheable (overridden by WC state).</td></tr></table> | <u>Bits</u> | <u>Description</u>                           | <u>Bits</u> | <u>Description</u> | 0h | UC or uncacheable.4h |  | WT or write through. | 1h | WC or write combining.5h |  | WP or write protect. | 2h | MBZ. | 6h | WB or write back. | 3h | MBZ. | 7h | UC- or uncacheable (overridden by WC state). |
| <u>Bits</u> | <u>Description</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <u>Bits</u> | <u>Description</u>                           |             |                    |    |                      |  |                      |    |                          |  |                      |    |      |    |                   |    |      |    |                                              |
| 0h          | UC or uncacheable.4h                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |             | WT or write through.                         |             |                    |    |                      |  |                      |    |                          |  |                      |    |      |    |                   |    |      |    |                                              |
| 1h          | WC or write combining.5h                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |             | WP or write protect.                         |             |                    |    |                      |  |                      |    |                          |  |                      |    |      |    |                   |    |      |    |                                              |
| 2h          | MBZ.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 6h          | WB or write back.                            |             |                    |    |                      |  |                      |    |                          |  |                      |    |      |    |                   |    |      |    |                                              |
| 3h          | MBZ.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 7h          | UC- or uncacheable (overridden by WC state). |             |                    |    |                      |  |                      |    |                          |  |                      |    |      |    |                   |    |      |    |                                              |

### MSR0000\_02FF MTRR Default Memory Type (MTRRdefType)

Per-compute-unit.

See [MSR0000\\_020\[F:0\]](#) for general MTRR information.

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                  |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 63:12 | MBZ.                                                                                                                                                                                                                                                                                                                                                         |
| 11    | <b>MtrrDefTypeEn: variable and fixed MTRR enable</b> . Read-write. Reset: 0. 1= <a href="#">MSR0000_020[F:0]</a> [Variable-Size MTRRs Base/Mask], and <a href="#">MSR0000_02[6F:68,59:58,50]</a> [Fixed-Size MTRRs] are enabled. 0=Fixed and variable MTRRs are not enabled.                                                                                 |
| 10    | <b>MtrrDefTypeFixEn: fixed MTRR enable</b> . Read-write. Reset: 0. 1= <a href="#">MSR0000_02[6F:68,59:58,50]</a> [Fixed-Size MTRRs] are enabled. This field is ignored (and the fixed MTRRs are not enabled) if <a href="#">MSR0000_02FF</a> [MtrrDefTypeEn]=0.                                                                                              |
| 9:8   | MBZ.                                                                                                                                                                                                                                                                                                                                                         |
| 7:0   | <b>MemType: memory type</b> . Read-write. Reset: 0. If MtrrDefTypeEn==1 then MemType specifies the memory type for memory space that is not specified by either the fixed or variable range MTRRs. If MtrrDefTypeEn==0 then the default memory type for all of memory is UC. Valid encodings are {00000b, <a href="#">MSR0000_02[6F:68,59:58,50][2:0]</a> }. |

### MSR0000\_0400 MC0 Machine Check Control (MC0\_CTL)

Read-write. Reset: 0000\_0000\_0000\_0000h. See [2.15.1 \[Machine Check Architecture\]](#). See [MSRC001\\_0044 \[DC Machine Check Control Mask \(MC0\\_CTL\\_MASK\)\]](#)

| Bits  | Description |
|-------|-------------|
| 63:12 | Unused.     |

|    |                                                                      |
|----|----------------------------------------------------------------------|
| 11 | Unused.                                                              |
| 10 | Unused.                                                              |
| 9  | <b>IntErrType1: internal error type 1.</b>                           |
| 8  | <b>IntErrType2: internal error type 2.</b>                           |
| 7  | <b>SRDE: read data error.</b> System read data errors on cache fill. |
| 6  | <b>LFE: line fill error.</b> Uncorrectable error on cache fill.      |
| 5  | <b>SCBP: SCB parity.</b>                                             |
| 4  | <b>SQP: store queue parity.</b>                                      |
| 3  | <b>LQP: load queue parity.</b>                                       |
| 2  | <b>DatP: data parity.</b>                                            |
| 1  | <b>TLBP: TLB parity.</b>                                             |
| 0  | <b>TagP: tag parity.</b>                                             |

#### MSR0000\_0401 MC0 Machine Check Status (MC0\_STATUS)

See 2.15.1 [Machine Check Architecture]. See MSRC001\_0015[McStatusWrEn]. Table 220 describes each error type. Table 221 describes the error codes and status register settings for each error type. MSR0000\_0001 is an alias of MSR0000\_0401.

| Bits | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 63   | <b>Val: error valid.</b> Read-write; set-by-hardware. Cold reset: 0. 1=This bit indicates that a valid error has been detected. This bit should be cleared to 0 by software after the register has been read.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 62   | <p><b>Overflow: error overflow.</b> Read-write; set-by-hardware. Cold reset: 0. 1=An error was detected while the valid bit (Val) was set; at least one error was not logged. Overflow is set independently of whether the existing error is overwritten.</p> <p>The following hierarchy identifies the error logging priorities.</p> <ol style="list-style-type: none"> <li>1. Uncorrectable errors</li> <li>2. Deferred errors</li> <li>3. Correctable errors</li> </ol> <p>The machine check mechanism handles the contents of MCi_STATUS during overflow as follows:</p> <ul style="list-style-type: none"> <li>• Higher priority errors overwrite lower priority errors.</li> <li>• New errors of equal or lower priority do not overwrite existing errors.</li> <li>• Uncorrectable errors which are not logged due to overflow result in setting PCC, unless the new uncorrectable error is of the same type and in the same reportable address range as the existing error.</li> </ul> |
| 61   | <b>UC: error uncorrected.</b> Read-write; Updated-by-hardware. Cold reset: 0. 1=The error was not corrected by hardware.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 60   | <b>En: error enable.</b> Read-write; Updated-by-hardware. Cold reset: 0. 1=MCA error reporting is enabled for this error, as indicated by MCi_CTL.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |

| 59    | <b>MiscV: miscellaneous error register valid.</b><br>Read-write; Updated-by-hardware. Cold reset: 0.<br>1=Valid thresholding in <a href="#">MSR0000_0403</a> .                                                                                                                                                                                                                                                  |      |             |    |       |    |       |    |       |    |       |       |          |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|----|-------|----|-------|----|-------|----|-------|-------|----------|
| 58    | <b>AddrV: error address valid.</b> Read-write; Updated-by-hardware. Cold reset: 0. 1=MCi_ADDR contains address information associated with the error.                                                                                                                                                                                                                                                           |      |             |    |       |    |       |    |       |    |       |       |          |
| 57    | <b>PCC: processor context corrupt.</b> Read-write; Updated-by-hardware. Cold reset: 0. 1=Hardware context held by the processor may have been corrupted. Continued operation of the system may have unpredictable results. The error is not recoverable or survivable, and the system should be reinitialized. See <a href="#">2.15.1.6.1 [Differentiation Between System-Fatal and Process-Fatal Errors]</a> . |      |             |    |       |    |       |    |       |    |       |       |          |
| 56:45 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                       |      |             |    |       |    |       |    |       |    |       |       |          |
| 44    | <b>Deferred: deferred error.</b><br>Read-write; Updated-by-hardware. Cold reset: 0.<br>1=A deferred error was created. A deferred error is the result of an uncorrectable data error which did not immediately cause a processor exception; the data is poisoned and an exception is deferred until the data is loaded by a core.                                                                               |      |             |    |       |    |       |    |       |    |       |       |          |
| 43    | <b>Poison: poison error.</b><br>Read-write; Updated-by-hardware. Cold reset: 0.<br>1=The error was the result of attempting to consume poisoned data. This indicator does not apply to <a href="#">MSR0000_0411 [MC4 Machine Check Status (MC4_STATUS)]</a> .                                                                                                                                                   |      |             |    |       |    |       |    |       |    |       |       |          |
| 42:40 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                       |      |             |    |       |    |       |    |       |    |       |       |          |
| 39:36 | <b>Way: cache way in error.</b> Read-write; Updated-by-hardware. Cold reset: 0. Indicates the cache way in error.<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>0h</td><td>Way 0</td></tr> <tr> <td>1h</td><td>Way 1</td></tr> <tr> <td>2h</td><td>Way 2</td></tr> <tr> <td>3h</td><td>Way 3</td></tr> <tr> <td>Fh-4h</td><td>Reserved</td></tr> </table>                                     | Bits | Description | 0h | Way 0 | 1h | Way 1 | 2h | Way 2 | 3h | Way 3 | Fh-4h | Reserved |
| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                     |      |             |    |       |    |       |    |       |    |       |       |          |
| 0h    | Way 0                                                                                                                                                                                                                                                                                                                                                                                                           |      |             |    |       |    |       |    |       |    |       |       |          |
| 1h    | Way 1                                                                                                                                                                                                                                                                                                                                                                                                           |      |             |    |       |    |       |    |       |    |       |       |          |
| 2h    | Way 2                                                                                                                                                                                                                                                                                                                                                                                                           |      |             |    |       |    |       |    |       |    |       |       |          |
| 3h    | Way 3                                                                                                                                                                                                                                                                                                                                                                                                           |      |             |    |       |    |       |    |       |    |       |       |          |
| Fh-4h | Reserved                                                                                                                                                                                                                                                                                                                                                                                                        |      |             |    |       |    |       |    |       |    |       |       |          |
| 35:21 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                       |      |             |    |       |    |       |    |       |    |       |       |          |
| 20:16 | <b>ErrorCodeExt: extended error code.</b> Read-write; Updated-by-hardware. Cold reset: 0. Logs an extended error code when an error is detected. This model-specific field is used in conjunction with ErrorCode to identify the error sub-type for root cause analysis (see <a href="#">2.15.1.5 [Error Code]</a> ). See <a href="#">Table 221</a> for expected values.                                        |      |             |    |       |    |       |    |       |    |       |       |          |
| 15:0  | <b>ErrorCode: error code.</b> Read-write; Updated-by-hardware. Cold reset: 0. See <a href="#">2.15.1.5 [Error Code]</a> for details on decoding this field. See <a href="#">Table 221</a> for expected values.                                                                                                                                                                                                  |      |             |    |       |    |       |    |       |    |       |       |          |

**Table 220: MC0 Error Descriptions**

| Error Type      | Error Sub-type | Description <sup>1</sup>                                                                                                                   | CTL <sup>2</sup> | EAC <sup>3</sup> |
|-----------------|----------------|--------------------------------------------------------------------------------------------------------------------------------------------|------------------|------------------|
| Line Fill Error | -              | An uncorrectable error occurred during a line fill from the L2 cache or the NB. (Note: For IO read, may not actually install to L1 cache.) | LineFillError    | E                |

**Table 220: MC0 Error Descriptions**

| Error Type                                                                                                                                                                                                                                                                                                                                                                                  | Error Sub-type  | Description <sup>1</sup>                                                                                             | CTL <sup>2</sup> | EAC <sup>3</sup> |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|----------------------------------------------------------------------------------------------------------------------|------------------|------------------|
| Data Cache Error                                                                                                                                                                                                                                                                                                                                                                            | Data array      | Error occurred in cache data array access.                                                                           | DatP             | D                |
|                                                                                                                                                                                                                                                                                                                                                                                             | SCB             | Error occurred in SCB access.                                                                                        | SCBP             | D                |
|                                                                                                                                                                                                                                                                                                                                                                                             | STQ             | Error occurred in STQ access.                                                                                        | SQP              | D                |
| Tag Error                                                                                                                                                                                                                                                                                                                                                                                   | Tag array       | A tag error was encountered. If uncorrectable, this errors is system fatal and results in a sync flood.              | TagP             | D                |
|                                                                                                                                                                                                                                                                                                                                                                                             | STQ             | Error occurred in STQ access.                                                                                        | SQP              | D                |
|                                                                                                                                                                                                                                                                                                                                                                                             | LDQ             | Error occurred in LDQ access.                                                                                        | LQP              | D                |
| L1 TLB Error                                                                                                                                                                                                                                                                                                                                                                                | TLB parity      | Parity error in L1 TLB access.                                                                                       | TLBP             | D                |
|                                                                                                                                                                                                                                                                                                                                                                                             | TLB multimatch  | Lookup hit on multiple entries.                                                                                      |                  | D                |
|                                                                                                                                                                                                                                                                                                                                                                                             | Locked TLB miss | TLB miss occurred after lock granted.                                                                                |                  | E                |
| System Read Data Error                                                                                                                                                                                                                                                                                                                                                                      | -               | An error occurred during an attempted read of data from the NB. Possible reasons include master abort, target abort. | SRDE             | E                |
| Internal Error                                                                                                                                                                                                                                                                                                                                                                              | IntErrType1     | An internal error condition was detected which prohibits the core from continuing execution.                         | IntErrType1      | E                |
|                                                                                                                                                                                                                                                                                                                                                                                             | IntErrType2     |                                                                                                                      | IntErrType2      | E                |
| <div>1. CID: core ID. All LS errors are reported to the affected core; see <a href="#">2.15.1.3 [Error Detection, Action, Logging, and Reporting]</a>.</div> <div>2. See <a href="#">MSR0000_0400</a>.</div> <div>3. EAC: D=Error action taken if detected. E=Error action taken if MCA bank enabled. See <a href="#">2.15.1.3 [Error Detection, Action, Logging, and Reporting]</a>.</div> |                 |                                                                                                                      |                  |                  |

**Table 221: MC0 Error Signatures**

| Error Type       | Error      | ErrorCodeExt | Error Code |       |   |      |       |    | UC  | ADDRV | PCC | Deferred | Poison |
|------------------|------------|--------------|------------|-------|---|------|-------|----|-----|-------|-----|----------|--------|
|                  |            |              | Type       | UU/PP | T | RRRR | II/TT | LL |     |       |     |          |        |
| Line Fill Error  | -          | 01h          | MEM        | -     | - | DRD  | D     | LG | 1   | 1     | 0   | -0       | -1     |
| Data Cache Error | Data array | 00h          |            |       |   | DRD  | D     | L1 | 0/1 | 1     | 0   | -0       | -0     |
|                  | SCB        | 03h          |            |       |   |      |       |    |     |       |     |          |        |
|                  | STQ        | 02h          |            |       |   |      |       |    |     |       |     |          |        |

**Table 221: MC0 Error Signatures**

| Error Type             | Error           | ErrorCodeExt | Error Code |       |     |                 |        |    | UC  | ADDRV | PCC | Deferred | Poison |
|------------------------|-----------------|--------------|------------|-------|-----|-----------------|--------|----|-----|-------|-----|----------|--------|
|                        |                 |              | Type       | UU/PP | T   | RRRR            | II/TT  | LL |     |       |     |          |        |
| Tag Error              | Tag array       | 10h          | MEM        | - SRC | - 0 | DRD, DWR, Probe | G      | L1 | 1   | 0/1   | 1   | -0       | -0     |
|                        | STQ             | 11h          |            |       |     | DWR             |        |    | 0/1 | 1     | 0/1 |          |        |
|                        | LDQ             | 12h          |            |       |     | DRD             |        |    | 0/1 | 1     | 0   |          |        |
| L1 TLB Error           | TLB parity      | 00h          | TLB        |       |     | -               | D      | L1 | 0/1 | 1     | 0   | -0       | -0     |
|                        | TLB Multimatch  | 01h          |            |       |     |                 |        |    | 0/1 | 0     |     |          |        |
|                        | Locked TLB miss | 02h          |            |       |     |                 |        |    | 1   | 1     |     |          |        |
| System Read Data Error | -               | 00h          | BUS        |       |     | DRD             | MEM/IO | LG | 1   | 1     | 0   | -0       | -0     |
| Internal Error         | Type1           | 01h          |            | GEN   | 1   | GEN             | GEN    | LG | 1   | 0     | 0   | -0       | -0     |
|                        | Type2           | 02h          |            |       |     |                 |        |    |     |       |     |          |        |

**MSR0000\_0402 MC0 Machine Check Address (MC0\_ADDR)**

Read-write; Updated-by-hardware. Cold reset: 0000\_0000\_0000\_0000h. The MCi\_ADDR register contains valid data if indicated by MCi\_STATUS[AddrV]. See 2.15.1 [Machine Check Architecture]. MSR0000\_0000 is an alias of MSR0000\_0402.

| Bits | Description                          |
|------|--------------------------------------|
| 63:0 | <b>ADDR:</b> Address. See Table 222. |

**Table 222: MC0 Address Register**

| Error Type       | Error Sub-type | Bits  | Description                                       |
|------------------|----------------|-------|---------------------------------------------------|
| Line Fill Error  | -              | 63:48 | Reserved                                          |
|                  |                | 47:6  | <b>PhysAddr[47:6].</b>                            |
|                  |                | 5:0   | Reserved                                          |
| Data Cache Error | Data array     | 63:48 | Reserved                                          |
|                  |                | 47:4  | <b>PhysAddr[47:4].</b>                            |
|                  |                | 3:0   | Reserved                                          |
| Data Cache Error | SCB            | 63:12 | Reserved                                          |
|                  |                | 11:4  | <b>PhysAddr[11:4].</b>                            |
|                  |                | 3:0   | Reserved                                          |
| Data Cache Error | STQ            | 63:5  | Reserved                                          |
|                  |                | 4:0   | <b>Index.</b>                                     |
| Tag Error        | Tag array      | 63:48 | Reserved                                          |
|                  |                | 47:6  | <b>PhysAddr[47:6].</b>                            |
|                  |                | 5:4   | <b>PhysAddr[5:4].</b> Not valid for probe errors. |
|                  |                | 3:0   | Reserved                                          |

**Table 222: MC0 Address Register**

| Error Type             | Error Sub-type  | Bits  | Description            |
|------------------------|-----------------|-------|------------------------|
|                        | STQ             | 63:5  | Reserved               |
|                        |                 | 4:0   | <b>Index.</b>          |
|                        | LDQ             | 63:6  | Reserved               |
|                        |                 | 5:0   | <b>Index.</b>          |
| L1 TLB Error           | TLB parity      | 63:48 | Reserved               |
|                        |                 | 47:12 | <b>LinAddr[47:12].</b> |
|                        |                 | 11:5  | Reserved               |
|                        |                 | 4:0   | <b>TlbIndex.</b>       |
|                        | Locked TLB miss | 63:48 | Reserved               |
|                        |                 | 47:12 | <b>LinAddr[47:12].</b> |
|                        |                 | 11:0  | Reserved               |
| System Read Data Error | -               | 63:48 | Reserved               |
|                        |                 | 47:6  | <b>PhysAddr[47:6].</b> |
|                        |                 | 5:0   | Reserved               |

**MSR0000\_0403 MC0 Machine Check Miscellaneous (MC0\_MISC)**

See 2.15.1.7 [Error Thresholding].

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                          |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 63    | <b>Valid.</b> IF ( <a href="#">MSRC001_0015</a> [McStatusWrEn]) THEN Read-write. ELSE Read-only. ENDIF. Reset: 1. 1=A valid CntP field is present in this register.                                                                                                                                                                                                                  |
| 62    | <b>CntP: counter present.</b> IF ( <a href="#">MSRC001_0015</a> [McStatusWrEn]) THEN Read-write. ELSE Read-only. ENDIF. Reset: 1. 1=A valid threshold counter is present.                                                                                                                                                                                                            |
| 61    | <b>Locked.</b> IF ( <a href="#">MSRC001_0015</a> [McStatusWrEn]) THEN Read-write. ELSE Read-only. ENDIF. Reset: 0. 1=Writes to this register are ignored. This bit is set by BIOS to indicate that this register is not available for OS use. BIOS should set this bit if IntType is set to SMI.                                                                                     |
| 60    | <b>IntP: Interrupt support present.</b> IF ( <a href="#">MSRC001_0015</a> [McStatusWrEn]   ~Locked) THEN Read-write. ELSE Read-only. ENDIF. Reset: 1. 1=IntType can be used to generate interrupts. 0=IntType and interrupt generation are not supported.                                                                                                                            |
| 59:56 | Reserved.                                                                                                                                                                                                                                                                                                                                                                            |
| 55:52 | <b>LvtOffset: LVT offset.</b> IF ( <a href="#">MSRC001_0015</a> [McStatusWrEn]   ~Locked) THEN Read-write. ELSE Read-only. ENDIF. Reset: 0000b. BIOS: 1. Specifies the address of the LVT entry in the APIC registers as follows: LVT address = (LvtOffset shifted left 4 bits) + 500h (see <a href="#">APIC[530:500]</a> ). Only values 0 through 3 are valid; all others reserved. |
| 51    | <b>CntEn: counter enable.</b> Read-write; Updated-by-hardware. Reset: 0. 1=Count thresholding errors. See 2.15.1.7 [Error Thresholding].                                                                                                                                                                                                                                             |

|       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 50:49 | <b>IntType: interrupt type.</b> Read-write. Cold reset: 0. Specifies the type of interrupt signaled when Ovrflw is set and IntP==1.<br><div> <div>Bits</div> <div>Description</div> </div> <div> <div>00b</div> <div>No Interrupt.</div> </div> <div> <div>01b</div> <div>APIC based interrupt (see LvtOffset above) to all cores.</div> </div> <div> <div>10b</div> <div>SMI trigger event (always routed to CpuCoreNum 0, as defined in 2.4.4 [Processor Cores and Downcoring]); see 2.4.10.2.3 [SMI Sources And Delivery].</div> </div> <div> <div>11b</div> <div>Reserved</div> </div> |
| 48    | <b>Ovrflw: overflow.</b> Read-write; set-by-hardware. Cold reset: 0. Set by hardware when ErrCnt transitions from FFEh to FFFh. When this field is set, ErrCnt no longer increments. When this bit is set and the IntP field==1, the interrupt selected by the IntType field is generated.                                                                                                                                                                                                                                                                                                 |
| 47:44 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 43:32 | <b>ErrCnt: error counter.</b> Read-write; updated-by-hardware. Cold reset: 0. This is written by software to set the starting value of the error counter. This is incremented by hardware when errors are logged. When this counter overflows, it stays at FFFh (no rollover). The threshold value, written by software, is (FFFh - the desired error count (the number of errors necessary in order for an interrupt to be taken)); the desired error count of 0 (a write value of FFFh) is not supported.                                                                                |
| 31:24 | <b>BlkPtr: Block pointer for additional MISC registers.</b> Read-only. Value: 00h. 00h=Extended MISC MSR block is not valid.                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 23:0  | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |

#### MSR0000\_0404 MC1 Machine Check Control (MC1\_CTL)

[Per-compute-unit](#); Read-write.

Reset: 0000\_0000\_0000\_0000h. See 2.15.1 [Machine Check Architecture].

| Bits  | Description                                            |
|-------|--------------------------------------------------------|
| 63:26 | Unused.                                                |
| 25    | Unused.                                                |
| 24    | Unused.                                                |
| 23    | <b>IVP: IC valid bit parity error.</b>                 |
| 22    | <b>L1TLBM: IC L1 TLB multi-match error.</b>            |
| 21    | <b>L2TLBM: IC L2 TLB multi-match error.</b>            |
| 20    | <b>DFIFOE: decoder FIFO parity error.</b>              |
| 19    | <b>DPDBE: decoder predecode buffer parity error.</b>   |
| 18    | <b>DEIBP: decoder instruction buffer parity error.</b> |
| 17    | <b>DEUOPQP: Decoder micro-op queue parity error.</b>   |
| 16    | <b>DEPRP: microcode patch buffer parity error.</b>     |
| 15    | <b>BSRP: branch status register parity error.</b>      |
| 14    | Unused.                                                |
| 13    | <b>PQP: prediction queue parity error.</b>             |
| 12    | <b>PFBP: prefetch buffer parity.</b>                   |

|       |                                                                      |
|-------|----------------------------------------------------------------------|
| 11:10 | Unused.                                                              |
| 9     | <b>SRDE: system read data error.</b>                                 |
| 8     | Unused.                                                              |
| 7     | <b>LFE: line fill error.</b> Uncorrectable error on cache line fill. |
| 6     | <b>L1TP: L1 TLB parity error.</b>                                    |
| 5     | <b>L2TP: L2 TLB parity error.</b>                                    |
| 4     | <b>ISTP: L1 cache probe tag array parity error.</b>                  |
| 3     | <b>IMTP: L1 cache main tag array parity error.</b>                   |
| 2     | <b>IDP: L1 cache data array parity errors.</b>                       |
| 1     | Unused.                                                              |
| 0     | Unused.                                                              |

### MSR0000\_0405 MC1 Machine Check Status (MC1\_STATUS)

See 2.15.1 [Machine Check Architecture]. See MSRC001\_0015[McStatusWrEn]. Table 223 describes each error type. Table 224 describes the error codes and status register settings for each error type.

| Bits  | Description                                                                                                                                                                                                                                                                                                                             |      |             |    |       |    |       |    |       |       |          |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|----|-------|----|-------|----|-------|-------|----------|
| 63    | <b>Val: error valid.</b> See: MSR0000_0401[Val].                                                                                                                                                                                                                                                                                        |      |             |    |       |    |       |    |       |       |          |
| 62    | <b>Overflow: error overflow.</b> See: MSR0000_0401[Overflow].                                                                                                                                                                                                                                                                           |      |             |    |       |    |       |    |       |       |          |
| 61    | <b>UC: error uncorrected.</b> See: MSR0000_0401[UC].                                                                                                                                                                                                                                                                                    |      |             |    |       |    |       |    |       |       |          |
| 60    | <b>En: error enable.</b> See: MSR0000_0401[En].                                                                                                                                                                                                                                                                                         |      |             |    |       |    |       |    |       |       |          |
| 59    | <b>MiscV: miscellaneous error register valid.</b><br>Read-write; Updated-by-hardware. Cold reset: 0.<br>See: MSR0000_0401[MiscV]. 1=Valid thresholding in MSR0000_0407.                                                                                                                                                                 |      |             |    |       |    |       |    |       |       |          |
| 58    | <b>AddrV: error address valid.</b> See: MSR0000_0401[AddrV].                                                                                                                                                                                                                                                                            |      |             |    |       |    |       |    |       |       |          |
| 57    | <b>PCC: processor context corrupt.</b> See: MSR0000_0401[PCC].                                                                                                                                                                                                                                                                          |      |             |    |       |    |       |    |       |       |          |
| 56:45 | Reserved.                                                                                                                                                                                                                                                                                                                               |      |             |    |       |    |       |    |       |       |          |
| 44    | <b>Deferred: deferred error.</b> See: MSR0000_0401[Deferred].                                                                                                                                                                                                                                                                           |      |             |    |       |    |       |    |       |       |          |
| 43    | <b>Poison: poison error.</b> See: MSR0000_0401[Poison].                                                                                                                                                                                                                                                                                 |      |             |    |       |    |       |    |       |       |          |
| 42:40 | Reserved.                                                                                                                                                                                                                                                                                                                               |      |             |    |       |    |       |    |       |       |          |
| 39:36 | <b>Way: cache way in error.</b> Read-write; Updated-by-hardware. Cold reset: 0. Indicates the cache way in error.<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>0h</td><td>Way 0</td></tr> <tr> <td>1h</td><td>Way 1</td></tr> <tr> <td>2h</td><td>Way 2</td></tr> <tr> <td>Fh-3h</td><td>Reserved</td></tr> </table> | Bits | Description | 0h | Way 0 | 1h | Way 1 | 2h | Way 2 | Fh-3h | Reserved |
| Bits  | Description                                                                                                                                                                                                                                                                                                                             |      |             |    |       |    |       |    |       |       |          |
| 0h    | Way 0                                                                                                                                                                                                                                                                                                                                   |      |             |    |       |    |       |    |       |       |          |
| 1h    | Way 1                                                                                                                                                                                                                                                                                                                                   |      |             |    |       |    |       |    |       |       |          |
| 2h    | Way 2                                                                                                                                                                                                                                                                                                                                   |      |             |    |       |    |       |    |       |       |          |
| Fh-3h | Reserved                                                                                                                                                                                                                                                                                                                                |      |             |    |       |    |       |    |       |       |          |
| 35:21 | Reserved.                                                                                                                                                                                                                                                                                                                               |      |             |    |       |    |       |    |       |       |          |



|       |                                                                                                                                                                                                                |
|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 20:16 | <b>ErrorCodeExt: extended error code.</b> Read-write; Updated-by-hardware. Cold reset: 0. See <a href="#">MSR0000_0401</a> [ErrorCodeExt]. See <a href="#">Table 224</a> for expected values.                  |
| 15:0  | <b>ErrorCode: error code.</b> Read-write; updated-by-hardware. Cold reset: 0. See <a href="#">2.15.1.5 [Error Code]</a> for details on decoding this field. See <a href="#">Table 224</a> for expected values. |

**Table 223: MC1 Error Descriptions**

| Error Type                   | Error                       | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | CTL <sup>3</sup> | CID <sup>2</sup> | EAC <sup>1</sup> |
|------------------------------|-----------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|------------------|------------------|
| Line Fill Error              | -                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | LineFill Poison  | A                | E                |
| Instruction cache read error | IC Data Load Parity         | A parity error occurred during load of data from the instruction cache. The data is discarded from the IC and can be refetched.                                                                                                                                                                                                                                                                                                                                                                                                                                            | IDP              | A                | D                |
|                              | IC valid bit                | Parity error for IC valid bit.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | IVP              | A                | D                |
|                              | Main tag                    | A main tag parity error occurred.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | IMTP             | A                | D                |
|                              | Prediction queue            | Parity error in prediction queue.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | PQP              | A                | E                |
|                              | PFB data/address            | PFB data/address had a parity error. A PFB valid bit error, PFB multimatch error, Line Fill Error, or ReadData Error may additionally cause a PFB data/address error.                                                                                                                                                                                                                                                                                                                                                                                                      | PFBP             | A                | E                |
|                              | PFB valid bit               | PFB valid bit had a parity error. This error may cause subsequent errors related to the entry, but the effect can be contained to the running process.                                                                                                                                                                                                                                                                                                                                                                                                                     |                  | B                | E                |
|                              | PFB non-cacheable bit       | PFB non-cacheable bit had a parity error.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                  | B                | E                |
|                              | PFB promotion address error | An address parity error was detected when promoting from the PFB to the IC.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                  | B                | E                |
|                              | Branch status register      | A parity error was discovered in the branch status register. This error is uncorrectable, but the effect can be contained to the running process.                                                                                                                                                                                                                                                                                                                                                                                                                          | BSRP             | A                | E                |
| Instruction cache read error | Microcode Patch Buffer      | Parity error in the microcode patch buffer. This error is uncorrectable. If a reset is not performed or the patch area is not reloaded, then it is recommended that the compute unit be removed from the running configuration by the operating system if possible. After a reset, BIST is used to determine whether there is a hard fault in the RAM. If a hard fault is not found, the error was likely a transient upset and the RAM is not broken. This error can also be caused by an error in the microcode patch region of the CC6 save area if ECC is not enabled. | DEPRP            | A                | E                |

**Table 223: MC1 Error Descriptions**

| Error Type                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Error                      | Description                                                                                                                 | CTL <sup>3</sup> | CID <sup>2</sup> | EAC <sup>1</sup> |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|-----------------------------------------------------------------------------------------------------------------------------|------------------|------------------|------------------|
| Instruction cache read error                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Decoder micro-op queue     | Parity error in decode unit. This error is correctable unless the operation is for a non-cacheable operand.                 | DEUQ             | A                | E                |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Decoder instruction buffer |                                                                                                                             | DEIBP            | A                | E                |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Decoder pre-decode buffer  |                                                                                                                             | DEPD             | A                | E                |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Decoder fetch address FIFO |                                                                                                                             | DEFF             | A                | E                |
| Tag Probe                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Probe tag error            | A tag error was encountered during probe or victimization.                                                                  | ISTP             | 0                | D                |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Probe tag valid bit        | Parity error for IC probe tag valid bit.                                                                                    | IVP              | 0                | D                |
| L1 TLB                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Parity                     | Parity error in L1 TLB.                                                                                                     | L1TP             | A                | D                |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Multimatch                 | Hit multiple entries in L1 TLB.                                                                                             | L1TLB M          | A                | D                |
| L2 TLB                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Parity                     | Parity error in L2 TLB.                                                                                                     | L2TP             | A                | D                |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Multimatch                 | Hit multiple entries in L2 TLB.                                                                                             | L2TLB M          | A                | D                |
| System Read Data Error                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | -                          | An error occurred during an attempted demand read of data from the NB. Possible reasons include master abort, target abort. | SRDE             | A                | E                |
| <ol style="list-style-type: none"> <li>1. EAC: D=Error action taken if detected. E=Error action taken if MCA bank enabled. See <a href="#">2.15.1.3 [Error Detection, Action, Logging, and Reporting]</a>.</li> <li>2. CID: core ID. A=Error reported to the affected core. 0=Error reported to core 0 of the Compute Unit. B=Error reported to all cores of the Compute Unit. See <a href="#">2.15.1.3 [Error Detection, Action, Logging, and Reporting]</a>.</li> <li>3. See <a href="#">MSR0000_0404</a>.</li> </ol> |                            |                                                                                                                             |                  |                  |                  |

**Table 224: MC1 Error Signatures**

| Error Type                   | Error                       | ErrorCod<br>eExt | Error Code |           |    |       |       |    | UC  | ADDRV | PCC | Deferred | Poison |
|------------------------------|-----------------------------|------------------|------------|-----------|----|-------|-------|----|-----|-------|-----|----------|--------|
|                              |                             |                  | Type       | UU/P<br>P | TT | RRRR  | II/TT | LL |     |       |     |          |        |
| Line Fill Error              | -                           | 00h              | MEM        | -         | -  | IRD   | I     | L2 | 1   | 1     | 0   | -0       | -1     |
| Instruction Cache Read Error | IC data load parity         | 01h              |            | -         | -  | IRD   | I     | L1 | 0   | 1     | 0   | -0       | -0     |
|                              | IC valid bit                | 02h              |            |           |    |       |       |    | 0   | 1     | 0   | -0       | -0     |
|                              | Main tag                    | 03h              |            |           |    |       |       |    | 0   | 1     | 0   | -0       | -0     |
|                              | Prediction queue            | 04h              |            |           |    |       |       |    | 1   | 0     | 0   | -0       | -0     |
|                              | PFB data/address            | 05h              |            |           |    |       |       |    | 0/1 | 0     | 0   | -0       | -0     |
|                              | PFB valid bit               | 0Dh              |            |           |    |       |       |    | 1   | 0     | 0   | -0       | -0     |
|                              | PFB non-cacheable bit       | 0Ah              |            |           |    |       |       |    | 0/1 | 0     | 0   | -0       | -0     |
|                              | PFB promotion address error | 07h              |            |           |    |       |       |    | 1   | 0     | 1   | -0       | -0     |
|                              | Branch status register      | 06h              |            |           |    |       |       |    | 1   | 0     | 0   | -0       | -0     |
|                              | Microcode Patch Buffer      | 10h              |            |           |    |       |       | LG | 1   | 1     | 1   | -0       | -0     |
|                              | Decoder micro-op queue      | 11h              |            |           |    |       |       | L1 | 0/1 | 1     | 0   | -0       | -0     |
|                              | Decoder instruction buffer  | 12h              |            |           |    |       |       |    | 0/1 | 1     | 0   | -0       | -0     |
|                              | Decoder pre-decode buffer   | 13h              |            |           |    |       |       |    | 0/1 | 0     | 0   | -0       | -0     |
|                              | Decoder fetch address FIFO  | 14h              |            |           |    |       |       |    | 0/1 | 1     | 0   | -0       | -0     |
| Tag Probe                    | Probe tag error             | 08h              | MEM        | -         | -  | Probe | I     | L1 | 0   | 1     | 0   | -0       | -0     |
|                              | Probe tag valid bit         | 09h              |            |           |    |       |       |    |     |       |     |          |        |
| L1 TLB                       | Parity                      | 00h              | TLB        | -         | -  | -     | I     | L1 | 0   | 1     | 0   | -0       | -0     |
|                              | Multimatch                  | 01h              |            |           |    |       |       |    |     |       |     |          |        |
| L2 TLB                       | Parity                      | 00h              |            |           |    |       |       | L2 |     |       |     |          |        |
|                              | Multimatch                  | 01h              |            |           |    |       |       |    |     |       |     |          |        |
| System Read Data Error       | -                           | 00h              | BUS        | SRC       | 0  | IRD   | MEM   | LG | 1   | 1     | 0   | -0       | -0     |

**MSR0000\_0406 MC1 Machine Check Address (MC1\_ADDR)**

Read-write; Updated-by-hardware. Cold reset: 0000\_0000\_0000\_0000h. The MCi\_ADDR register contains

valid data if indicated by MCi\_STATUS[AddrV]. See 2.15.1 [Machine Check Architecture].

| Bits | Description                          |
|------|--------------------------------------|
| 63:0 | <b>ADDR: Address.</b> See Table 225. |

The following table defines the address register as a function of error type.

**Table 225: MC1 Address Register**

| Error Type                   | Error Sub-Type                                                                                                                                                                                                                        | Bits         | Description                                                                                                                                                                                                                                       |              |                    |     |        |     |        |     |          |     |        |
|------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|--------------------|-----|--------|-----|--------|-----|----------|-----|--------|
| Line Fill Error              | -                                                                                                                                                                                                                                     | 63:48        | Reserved                                                                                                                                                                                                                                          |              |                    |     |        |     |        |     |          |     |        |
|                              |                                                                                                                                                                                                                                       | 47:6         | <b>LinAddr[47:6].</b>                                                                                                                                                                                                                             |              |                    |     |        |     |        |     |          |     |        |
|                              |                                                                                                                                                                                                                                       | 5:0          | Reserved                                                                                                                                                                                                                                          |              |                    |     |        |     |        |     |          |     |        |
| Instruction cache read error | IC data load parity                                                                                                                                                                                                                   | 63:48        | Reserved                                                                                                                                                                                                                                          |              |                    |     |        |     |        |     |          |     |        |
|                              |                                                                                                                                                                                                                                       | 47:3         | <b>LinAddr[47:3].</b><br><table><tr><th><u>[7:6]</u></th><th><u>Description</u></th></tr><tr><td>00b</td><td>Bank 0</td></tr><tr><td>01b</td><td>Bank 1</td></tr><tr><td>10b</td><td>Bank 2</td></tr><tr><td>11b</td><td>Bank 3</td></tr></table> | <u>[7:6]</u> | <u>Description</u> | 00b | Bank 0 | 01b | Bank 1 | 10b | Bank 2   | 11b | Bank 3 |
|                              |                                                                                                                                                                                                                                       | <u>[7:6]</u> | <u>Description</u>                                                                                                                                                                                                                                |              |                    |     |        |     |        |     |          |     |        |
|                              |                                                                                                                                                                                                                                       | 00b          | Bank 0                                                                                                                                                                                                                                            |              |                    |     |        |     |        |     |          |     |        |
|                              |                                                                                                                                                                                                                                       | 01b          | Bank 1                                                                                                                                                                                                                                            |              |                    |     |        |     |        |     |          |     |        |
| 10b                          | Bank 2                                                                                                                                                                                                                                |              |                                                                                                                                                                                                                                                   |              |                    |     |        |     |        |     |          |     |        |
| 11b                          | Bank 3                                                                                                                                                                                                                                |              |                                                                                                                                                                                                                                                   |              |                    |     |        |     |        |     |          |     |        |
| 2:1                          | <b>Way.</b><br><table><tr><th><u>Bits</u></th><th><u>Description</u></th></tr><tr><td>00b</td><td>Way 0</td></tr><tr><td>01b</td><td>Way 1</td></tr><tr><td>10b</td><td>Way 2</td></tr><tr><td>11b</td><td>Reserved</td></tr></table> | <u>Bits</u>  | <u>Description</u>                                                                                                                                                                                                                                | 00b          | Way 0              | 01b | Way 1  | 10b | Way 2  | 11b | Reserved |     |        |
| <u>Bits</u>                  | <u>Description</u>                                                                                                                                                                                                                    |              |                                                                                                                                                                                                                                                   |              |                    |     |        |     |        |     |          |     |        |
| 00b                          | Way 0                                                                                                                                                                                                                                 |              |                                                                                                                                                                                                                                                   |              |                    |     |        |     |        |     |          |     |        |
| 01b                          | Way 1                                                                                                                                                                                                                                 |              |                                                                                                                                                                                                                                                   |              |                    |     |        |     |        |     |          |     |        |
| 10b                          | Way 2                                                                                                                                                                                                                                 |              |                                                                                                                                                                                                                                                   |              |                    |     |        |     |        |     |          |     |        |
| 11b                          | Reserved                                                                                                                                                                                                                              |              |                                                                                                                                                                                                                                                   |              |                    |     |        |     |        |     |          |     |        |
| 0                            | Reserved                                                                                                                                                                                                                              |              |                                                                                                                                                                                                                                                   |              |                    |     |        |     |        |     |          |     |        |
|                              |                                                                                                                                                                                                                                       |              |                                                                                                                                                                                                                                                   |              |                    |     |        |     |        |     |          |     |        |
| Instruction cache read error | IC valid bit                                                                                                                                                                                                                          | 63:48        | Reserved                                                                                                                                                                                                                                          |              |                    |     |        |     |        |     |          |     |        |
|                              |                                                                                                                                                                                                                                       | 47:6         | <b>LinAddr[47:6].</b><br><table><tr><th><u>[7:6]</u></th><th><u>Description</u></th></tr><tr><td>00b</td><td>Bank 0</td></tr><tr><td>01b</td><td>Bank 1</td></tr><tr><td>10b</td><td>Bank 2</td></tr><tr><td>11b</td><td>Bank 3</td></tr></table> | <u>[7:6]</u> | <u>Description</u> | 00b | Bank 0 | 01b | Bank 1 | 10b | Bank 2   | 11b | Bank 3 |
|                              |                                                                                                                                                                                                                                       | <u>[7:6]</u> | <u>Description</u>                                                                                                                                                                                                                                |              |                    |     |        |     |        |     |          |     |        |
| 00b                          | Bank 0                                                                                                                                                                                                                                |              |                                                                                                                                                                                                                                                   |              |                    |     |        |     |        |     |          |     |        |
| 01b                          | Bank 1                                                                                                                                                                                                                                |              |                                                                                                                                                                                                                                                   |              |                    |     |        |     |        |     |          |     |        |
| 10b                          | Bank 2                                                                                                                                                                                                                                |              |                                                                                                                                                                                                                                                   |              |                    |     |        |     |        |     |          |     |        |
| 11b                          | Bank 3                                                                                                                                                                                                                                |              |                                                                                                                                                                                                                                                   |              |                    |     |        |     |        |     |          |     |        |
| 5:0                          | Reserved                                                                                                                                                                                                                              |              |                                                                                                                                                                                                                                                   |              |                    |     |        |     |        |     |          |     |        |

**Table 225: MC1 Address Register**

| Error Type                   | Error Sub-Type                                                                                                                                                                                                                        | Bits        | Description                                                                                                                                                                                                                                                                                                                            |             |                    |     |                           |     |                           |     |                           |     |                           |
|------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|--------------------|-----|---------------------------|-----|---------------------------|-----|---------------------------|-----|---------------------------|
| Instruction cache read error | Main tag                                                                                                                                                                                                                              | 63:48       | Reserved                                                                                                                                                                                                                                                                                                                               |             |                    |     |                           |     |                           |     |                           |     |                           |
|                              |                                                                                                                                                                                                                                       | 47:6        | <b>LinAddr[47:6].</b><br><table><tr><th><u>Bits</u></th><th><u>Description</u></th></tr><tr><td>00b</td><td>Bank 0</td></tr><tr><td>01b</td><td>Bank 1</td></tr><tr><td>10b</td><td>Bank 2</td></tr><tr><td>11b</td><td>Bank 3</td></tr></table>                                                                                       | <u>Bits</u> | <u>Description</u> | 00b | Bank 0                    | 01b | Bank 1                    | 10b | Bank 2                    | 11b | Bank 3                    |
|                              |                                                                                                                                                                                                                                       | <u>Bits</u> | <u>Description</u>                                                                                                                                                                                                                                                                                                                     |             |                    |     |                           |     |                           |     |                           |     |                           |
|                              |                                                                                                                                                                                                                                       | 00b         | Bank 0                                                                                                                                                                                                                                                                                                                                 |             |                    |     |                           |     |                           |     |                           |     |                           |
|                              |                                                                                                                                                                                                                                       | 01b         | Bank 1                                                                                                                                                                                                                                                                                                                                 |             |                    |     |                           |     |                           |     |                           |     |                           |
| 10b                          | Bank 2                                                                                                                                                                                                                                |             |                                                                                                                                                                                                                                                                                                                                        |             |                    |     |                           |     |                           |     |                           |     |                           |
| 11b                          | Bank 3                                                                                                                                                                                                                                |             |                                                                                                                                                                                                                                                                                                                                        |             |                    |     |                           |     |                           |     |                           |     |                           |
| 5:3                          | Reserved                                                                                                                                                                                                                              |             |                                                                                                                                                                                                                                                                                                                                        |             |                    |     |                           |     |                           |     |                           |     |                           |
| 2:1                          | <b>Way.</b><br><table><tr><th><u>Bits</u></th><th><u>Description</u></th></tr><tr><td>00b</td><td>Way 0</td></tr><tr><td>01b</td><td>Way 1</td></tr><tr><td>10b</td><td>Way 2</td></tr><tr><td>11b</td><td>Reserved</td></tr></table> | <u>Bits</u> | <u>Description</u>                                                                                                                                                                                                                                                                                                                     | 00b         | Way 0              | 01b | Way 1                     | 10b | Way 2                     | 11b | Reserved                  |     |                           |
| <u>Bits</u>                  | <u>Description</u>                                                                                                                                                                                                                    |             |                                                                                                                                                                                                                                                                                                                                        |             |                    |     |                           |     |                           |     |                           |     |                           |
| 00b                          | Way 0                                                                                                                                                                                                                                 |             |                                                                                                                                                                                                                                                                                                                                        |             |                    |     |                           |     |                           |     |                           |     |                           |
| 01b                          | Way 1                                                                                                                                                                                                                                 |             |                                                                                                                                                                                                                                                                                                                                        |             |                    |     |                           |     |                           |     |                           |     |                           |
| 10b                          | Way 2                                                                                                                                                                                                                                 |             |                                                                                                                                                                                                                                                                                                                                        |             |                    |     |                           |     |                           |     |                           |     |                           |
| 11b                          | Reserved                                                                                                                                                                                                                              |             |                                                                                                                                                                                                                                                                                                                                        |             |                    |     |                           |     |                           |     |                           |     |                           |
| 1:0                          | Reserved                                                                                                                                                                                                                              |             |                                                                                                                                                                                                                                                                                                                                        |             |                    |     |                           |     |                           |     |                           |     |                           |
| Instruction Cache Read Error | Microcode Patch Buffer                                                                                                                                                                                                                | 63:4        | Reserved                                                                                                                                                                                                                                                                                                                               |             |                    |     |                           |     |                           |     |                           |     |                           |
|                              |                                                                                                                                                                                                                                       | 3:0         | Line group index.                                                                                                                                                                                                                                                                                                                      |             |                    |     |                           |     |                           |     |                           |     |                           |
| Instruction cache read error | Decoder micro-op queue                                                                                                                                                                                                                | 63:2        | Reserved                                                                                                                                                                                                                                                                                                                               |             |                    |     |                           |     |                           |     |                           |     |                           |
|                              |                                                                                                                                                                                                                                       | 1:0         | Micro-op queue slot in error.                                                                                                                                                                                                                                                                                                          |             |                    |     |                           |     |                           |     |                           |     |                           |
| Instruction cache read error | Decoder instruction buffer                                                                                                                                                                                                            | 63:3        | Reserved                                                                                                                                                                                                                                                                                                                               |             |                    |     |                           |     |                           |     |                           |     |                           |
|                              |                                                                                                                                                                                                                                       | 2           | <b>PrefixMaskMismatch.</b> If (PrefixMaskMismatch==1) then BankAndParityBitInError=00b.                                                                                                                                                                                                                                                |             |                    |     |                           |     |                           |     |                           |     |                           |
|                              |                                                                                                                                                                                                                                       | 1:0         | <b>BankAndParityBitInError.</b><br><table><tr><th><u>Bits</u></th><th><u>Description</u></th></tr><tr><td>00b</td><td>Bank A, parity bit 0 or 1</td></tr><tr><td>01b</td><td>Bank B, parity bit 0 or 1</td></tr><tr><td>10b</td><td>Bank A, parity bit 2 or 3</td></tr><tr><td>11b</td><td>Bank B, parity bit 2 or 3</td></tr></table> | <u>Bits</u> | <u>Description</u> | 00b | Bank A, parity bit 0 or 1 | 01b | Bank B, parity bit 0 or 1 | 10b | Bank A, parity bit 2 or 3 | 11b | Bank B, parity bit 2 or 3 |
| <u>Bits</u>                  | <u>Description</u>                                                                                                                                                                                                                    |             |                                                                                                                                                                                                                                                                                                                                        |             |                    |     |                           |     |                           |     |                           |     |                           |
| 00b                          | Bank A, parity bit 0 or 1                                                                                                                                                                                                             |             |                                                                                                                                                                                                                                                                                                                                        |             |                    |     |                           |     |                           |     |                           |     |                           |
| 01b                          | Bank B, parity bit 0 or 1                                                                                                                                                                                                             |             |                                                                                                                                                                                                                                                                                                                                        |             |                    |     |                           |     |                           |     |                           |     |                           |
| 10b                          | Bank A, parity bit 2 or 3                                                                                                                                                                                                             |             |                                                                                                                                                                                                                                                                                                                                        |             |                    |     |                           |     |                           |     |                           |     |                           |
| 11b                          | Bank B, parity bit 2 or 3                                                                                                                                                                                                             |             |                                                                                                                                                                                                                                                                                                                                        |             |                    |     |                           |     |                           |     |                           |     |                           |
| Instruction cache read error | Decoder fetch address FIFO                                                                                                                                                                                                            | 63:2        | Reserved                                                                                                                                                                                                                                                                                                                               |             |                    |     |                           |     |                           |     |                           |     |                           |
|                              |                                                                                                                                                                                                                                       | 1           | <b>BsrTagParityError.</b>                                                                                                                                                                                                                                                                                                              |             |                    |     |                           |     |                           |     |                           |     |                           |
|                              |                                                                                                                                                                                                                                       | 0           | <b>BankInError.</b> 0=Bank A. 1=Bank B.                                                                                                                                                                                                                                                                                                |             |                    |     |                           |     |                           |     |                           |     |                           |

**Table 225: MC1 Address Register**

| Error Type | Error Sub-Type                                                                                                                                                                                                                                                                                                        | Bits       | Description                                                                                                                                                                                                                 |            |                    |     |        |     |        |     |        |     |        |     |        |
|------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|--------------------|-----|--------|-----|--------|-----|--------|-----|--------|-----|--------|
| Tag Probe  | Probe tag error                                                                                                                                                                                                                                                                                                       | 63:50      | Reserved                                                                                                                                                                                                                    |            |                    |     |        |     |        |     |        |     |        |     |        |
|            |                                                                                                                                                                                                                                                                                                                       | 49:48      | <b>BankBitmask.</b><br><table><tr><th><u>Bit</u></th><th><u>Description</u></th></tr><tr><td>[0]</td><td>Bank 6</td></tr><tr><td>[1]</td><td>Bank 7</td></tr></table>                                                       | <u>Bit</u> | <u>Description</u> | [0] | Bank 6 | [1] | Bank 7 |     |        |     |        |     |        |
|            |                                                                                                                                                                                                                                                                                                                       | <u>Bit</u> | <u>Description</u>                                                                                                                                                                                                          |            |                    |     |        |     |        |     |        |     |        |     |        |
|            |                                                                                                                                                                                                                                                                                                                       | [0]        | Bank 6                                                                                                                                                                                                                      |            |                    |     |        |     |        |     |        |     |        |     |        |
| [1]        | Bank 7                                                                                                                                                                                                                                                                                                                |            |                                                                                                                                                                                                                             |            |                    |     |        |     |        |     |        |     |        |     |        |
| 47:6       | <b>PhysAddr[47:6].</b>                                                                                                                                                                                                                                                                                                |            |                                                                                                                                                                                                                             |            |                    |     |        |     |        |     |        |     |        |     |        |
| 5:0        | <b>BankBitmask.</b><br><table><tr><th><u>Bit</u></th><th><u>Description</u></th></tr><tr><td>[0]</td><td>Bank 0</td></tr><tr><td>[1]</td><td>Bank 1</td></tr><tr><td>[2]</td><td>Bank 2</td></tr><tr><td>[3]</td><td>Bank 3</td></tr><tr><td>[4]</td><td>Bank 4</td></tr><tr><td>[5]</td><td>Bank 5</td></tr></table> | <u>Bit</u> | <u>Description</u>                                                                                                                                                                                                          | [0]        | Bank 0             | [1] | Bank 1 | [2] | Bank 2 | [3] | Bank 3 | [4] | Bank 4 | [5] | Bank 5 |
| <u>Bit</u> | <u>Description</u>                                                                                                                                                                                                                                                                                                    |            |                                                                                                                                                                                                                             |            |                    |     |        |     |        |     |        |     |        |     |        |
| [0]        | Bank 0                                                                                                                                                                                                                                                                                                                |            |                                                                                                                                                                                                                             |            |                    |     |        |     |        |     |        |     |        |     |        |
| [1]        | Bank 1                                                                                                                                                                                                                                                                                                                |            |                                                                                                                                                                                                                             |            |                    |     |        |     |        |     |        |     |        |     |        |
| [2]        | Bank 2                                                                                                                                                                                                                                                                                                                |            |                                                                                                                                                                                                                             |            |                    |     |        |     |        |     |        |     |        |     |        |
| [3]        | Bank 3                                                                                                                                                                                                                                                                                                                |            |                                                                                                                                                                                                                             |            |                    |     |        |     |        |     |        |     |        |     |        |
| [4]        | Bank 4                                                                                                                                                                                                                                                                                                                |            |                                                                                                                                                                                                                             |            |                    |     |        |     |        |     |        |     |        |     |        |
| [5]        | Bank 5                                                                                                                                                                                                                                                                                                                |            |                                                                                                                                                                                                                             |            |                    |     |        |     |        |     |        |     |        |     |        |
| Tag Probe  | Probe tag valid bit                                                                                                                                                                                                                                                                                                   | 63:48      | Reserved                                                                                                                                                                                                                    |            |                    |     |        |     |        |     |        |     |        |     |        |
|            |                                                                                                                                                                                                                                                                                                                       | 47:6       | <b>PhysAddr[47:6].</b>                                                                                                                                                                                                      |            |                    |     |        |     |        |     |        |     |        |     |        |
|            |                                                                                                                                                                                                                                                                                                                       | 5:0        | Reserved                                                                                                                                                                                                                    |            |                    |     |        |     |        |     |        |     |        |     |        |
| L1 TLB     | Parity, Multimatch                                                                                                                                                                                                                                                                                                    | 63:48      | Reserved                                                                                                                                                                                                                    |            |                    |     |        |     |        |     |        |     |        |     |        |
|            |                                                                                                                                                                                                                                                                                                                       | 47:12      | <b>LinAddr[47:12].</b><br>4-KB page: <ul style="list-style-type: none"><li>[47:12]: LinAddr[47:12].</li></ul> 2-MB page: <ul style="list-style-type: none"><li>[47:20]: LinAddr[47:20].</li><li>[19:12]: Reserved</li></ul> |            |                    |     |        |     |        |     |        |     |        |     |        |
|            |                                                                                                                                                                                                                                                                                                                       | 11:3       | Reserved                                                                                                                                                                                                                    |            |                    |     |        |     |        |     |        |     |        |     |        |
|            |                                                                                                                                                                                                                                                                                                                       | 2:0        | <b>BankBitmask.</b><br><table><tr><th><u>Bit</u></th><th><u>Description</u></th></tr><tr><td>[0]</td><td>Bank 0</td></tr><tr><td>[1]</td><td>Bank 1</td></tr><tr><td>[2]</td><td>Bank 2</td></tr></table>                   | <u>Bit</u> | <u>Description</u> | [0] | Bank 0 | [1] | Bank 1 | [2] | Bank 2 |     |        |     |        |
| <u>Bit</u> | <u>Description</u>                                                                                                                                                                                                                                                                                                    |            |                                                                                                                                                                                                                             |            |                    |     |        |     |        |     |        |     |        |     |        |
| [0]        | Bank 0                                                                                                                                                                                                                                                                                                                |            |                                                                                                                                                                                                                             |            |                    |     |        |     |        |     |        |     |        |     |        |
| [1]        | Bank 1                                                                                                                                                                                                                                                                                                                |            |                                                                                                                                                                                                                             |            |                    |     |        |     |        |     |        |     |        |     |        |
| [2]        | Bank 2                                                                                                                                                                                                                                                                                                                |            |                                                                                                                                                                                                                             |            |                    |     |        |     |        |     |        |     |        |     |        |
| L2 TLB     | Parity, Multimatch                                                                                                                                                                                                                                                                                                    | 63:48      | Reserved                                                                                                                                                                                                                    |            |                    |     |        |     |        |     |        |     |        |     |        |
|            |                                                                                                                                                                                                                                                                                                                       | 47:12      | <b>LinAddr[47:12].</b> (4-KB page size only)                                                                                                                                                                                |            |                    |     |        |     |        |     |        |     |        |     |        |
|            |                                                                                                                                                                                                                                                                                                                       | 11:4       | Reserved                                                                                                                                                                                                                    |            |                    |     |        |     |        |     |        |     |        |     |        |
|            |                                                                                                                                                                                                                                                                                                                       | 3:0        | <b>MatchLines.</b>                                                                                                                                                                                                          |            |                    |     |        |     |        |     |        |     |        |     |        |

**MSR0000\_0407 MC1 Machine Check Miscellaneous (MC1\_MISC)**

Cold reset: 0000\_0000\_0000\_0000h.

See 2.15.1.7 [Error Thresholding].

| Bits | Description                                                             |
|------|-------------------------------------------------------------------------|
| 63   | <b>Valid.</b> See: <a href="#">MSR0000_0403[Valid]</a> .                |
| 62   | <b>CntP: counter present.</b> See: <a href="#">MSR0000_0403[CntP]</a> . |

|       |                                                                                                         |
|-------|---------------------------------------------------------------------------------------------------------|
| 61    | <b>Locked.</b> See: <a href="#">MSR0000_0403</a> [Locked].                                              |
| 60    | <b>IntP: Interrupt support present.</b> See: <a href="#">MSR0000_0403</a> [IntP].                       |
| 59:56 | Reserved.                                                                                               |
| 55:52 | <b>LvtOffset: LVT offset.</b> See: <a href="#">MSR0000_0403</a> [LvtOffset].                            |
| 51    | <b>CntEn: counter enable.</b> See: <a href="#">MSR0000_0403</a> [CntEn].                                |
| 50:49 | <b>IntType: interrupt type.</b> See: <a href="#">MSR0000_0403</a> [IntType].                            |
| 48    | <b>Ovrflw: overflow.</b> See: <a href="#">MSR0000_0403</a> [Ovrflw].                                    |
| 47:44 | Reserved.                                                                                               |
| 43:32 | <b>ErrCnt: error counter.</b> See: <a href="#">MSR0000_0403</a> [ErrCnt].                               |
| 31:24 | <b>BlkPtr: Block pointer for additional MISC registers.</b> See: <a href="#">MSR0000_0403</a> [BlkPtr]. |
| 23:0  | Reserved.                                                                                               |

### MSR0000\_0408 MC2 Machine Check Control (MC2\_CTL)

Read-write; [Per-compute-unit](#).

Reset: 0000\_0000\_0000\_0000h. See [2.15.1 \[Machine Check Architecture\]](#). See [MSRC001\\_0046 \[BU Machine Check Control Mask \(MC2\\_CTL\\_MASK\)\]](#).

| Bits  | Description                                                           |
|-------|-----------------------------------------------------------------------|
| 63:16 | Unused.                                                               |
| 15    | Unused.                                                               |
| 14    | <b>L2TlbPoison: TLB fill poison error from L2.</b>                    |
| 13    | <b>RdData: read data error from NB.</b>                               |
| 12    | <b>L2Tag: L2 cache tag error.</b>                                     |
| 11    | <b>L2TlbData: L2 TLB parity error.</b> Parity error reading from TLB. |
| 10    | <b>L2Prefetch: L2 data prefetcher parity error.</b>                   |
| 9     | <b>XabAddr: XAB address parity error.</b>                             |
| 8     | <b>PrbAddr: probe buffer address parity error.</b>                    |
| 7     | <b>FillData: fill data parity and ECC error.</b>                      |
| 6     | <b>PrqAddr: post retire queue address parity error.</b>               |
| 5     | <b>PrqData: post retire queue data parity error.</b>                  |
| 4     | <b>WccAddr: write coalescing cache address ECC error.</b>             |
| 3     | <b>WccData: write coalescing cache data ECC error.</b>                |
| 2     | <b>WcbData: write combining buffer data parity error.</b>             |
| 1     | <b>VbData: victim buffer data parity and ECC error.</b>               |
| 0     | <b>L2TagMultiHit: L2 tag multiple hit error.</b>                      |

### MSR0000\_0409 MC2 Machine Check Status (MC2\_STATUS)

See [2.15.1 \[Machine Check Architecture\]](#). See [MSRC001\\_0015](#)[McStatusWrEn]. [Table 227](#) describes each

error type. [Table 228](#) describes the error codes and status register settings for each error type.

| Bits     | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |       |             |        |                |         |                 |         |                |          |                |
|----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|-------------|--------|----------------|---------|-----------------|---------|----------------|----------|----------------|
| 63       | <b>Val: error valid.</b> See: <a href="#">MSR0000_0401[Val]</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                      |       |             |        |                |         |                 |         |                |          |                |
| 62       | <b>Overflow: error overflow.</b> See: <a href="#">MSR0000_0401[Overflow]</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                         |       |             |        |                |         |                 |         |                |          |                |
| 61       | <b>UC: error uncorrected.</b> See: <a href="#">MSR0000_0401[UC]</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                  |       |             |        |                |         |                 |         |                |          |                |
| 60       | <b>En: error enable.</b> See: <a href="#">MSR0000_0401[En]</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                       |       |             |        |                |         |                 |         |                |          |                |
| 59       | <b>MiscV: miscellaneous error register valid.</b><br>Read-write; Updated-by-hardware. Cold reset: 0.<br>See: <a href="#">MSR0000_0401[MiscV]</a> . 1=Valid thresholding in <a href="#">MSR0000_040B</a> .                                                                                                                                                                                                                                                                                                              |       |             |        |                |         |                 |         |                |          |                |
| 58       | <b>AddrV: error address valid.</b> See: <a href="#">MSR0000_0401[AddrV]</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                          |       |             |        |                |         |                 |         |                |          |                |
| 57       | <b>PCC: processor context corrupt.</b> See: <a href="#">MSR0000_0401[PCC]</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                        |       |             |        |                |         |                 |         |                |          |                |
| 56       | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |       |             |        |                |         |                 |         |                |          |                |
| 55       | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |       |             |        |                |         |                 |         |                |          |                |
| 54:47    | <b>Syndromes[7:0].</b> Read-write; Updated-by-hardware. Cold reset: 0. The syndrome bits when an ECC error is detected. See <a href="#">Table 228</a> for when Syndrome[11:0] is valid.<br>Syndrome[11:0] = {Syndrome[11:8], Syndrome[7:0]}.<br><table> <tr> <th>Array</th><th>Description</th></tr> <tr> <td>L2 Tag</td><td>Syndrome[7:0].</td></tr> <tr> <td>WCC Tag</td><td>Syndrome[11:0].</td></tr> <tr> <td>L2 Data</td><td>Syndrome[8:0].</td></tr> <tr> <td>WCC Data</td><td>Syndrome[8:0].</td></tr> </table> | Array | Description | L2 Tag | Syndrome[7:0]. | WCC Tag | Syndrome[11:0]. | L2 Data | Syndrome[8:0]. | WCC Data | Syndrome[8:0]. |
| Array    | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |       |             |        |                |         |                 |         |                |          |                |
| L2 Tag   | Syndrome[7:0].                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |       |             |        |                |         |                 |         |                |          |                |
| WCC Tag  | Syndrome[11:0].                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |       |             |        |                |         |                 |         |                |          |                |
| L2 Data  | Syndrome[8:0].                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |       |             |        |                |         |                 |         |                |          |                |
| WCC Data | Syndrome[8:0].                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |       |             |        |                |         |                 |         |                |          |                |
| 46       | <b>CECC: correctable ECC error.</b> Read-write; Updated-by-hardware. Cold reset: 0. 1=The error was a correctable ECC error.                                                                                                                                                                                                                                                                                                                                                                                           |       |             |        |                |         |                 |         |                |          |                |
| 45       | <b>UECC: uncorrectable ECC error.</b> Read-write; updated-by-hardware. Cold reset: 0. 1=The error was an uncorrectable ECC error.                                                                                                                                                                                                                                                                                                                                                                                      |       |             |        |                |         |                 |         |                |          |                |
| 44       | <b>Deferred: deferred error.</b> See: <a href="#">MSR0000_0401[Deferred]</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                         |       |             |        |                |         |                 |         |                |          |                |
| 43       | <b>Poison: poison error.</b> See: <a href="#">MSR0000_0401[Poison]</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                               |       |             |        |                |         |                 |         |                |          |                |
| 42:40    | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |       |             |        |                |         |                 |         |                |          |                |
| 39:36    | <b>Way: cache way in error.</b> Read-write; Updated-by-hardware. Cold reset: 0. Indicates the cache way in error. See <a href="#">Table 228</a> for when Way is valid and what ways are valid.<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>0h</td><td>Way 0</td></tr> <tr> <td>1h</td><td>Way 1</td></tr> <tr> <td>Eh-2h</td><td>Way &lt;Way&gt;</td></tr> <tr> <td>Fh</td><td>Way 15</td></tr> </table>                                                                                           | Bits  | Description | 0h     | Way 0          | 1h      | Way 1           | Eh-2h   | Way <Way>      | Fh       | Way 15         |
| Bits     | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |       |             |        |                |         |                 |         |                |          |                |
| 0h       | Way 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |       |             |        |                |         |                 |         |                |          |                |
| 1h       | Way 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |       |             |        |                |         |                 |         |                |          |                |
| Eh-2h    | Way <Way>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |       |             |        |                |         |                 |         |                |          |                |
| Fh       | Way 15                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |       |             |        |                |         |                 |         |                |          |                |
| 35:32    | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |       |             |        |                |         |                 |         |                |          |                |
| 31:28    | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |       |             |        |                |         |                 |         |                |          |                |
| 27:24    | <b>Syndromes[11:8].</b> See: <a href="#">MSR0000_0409[Syndrome[7:0]]</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                             |       |             |        |                |         |                 |         |                |          |                |
| 23:21    | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |       |             |        |                |         |                 |         |                |          |                |



|       |                                                                                                                                                                                                                |
|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 20:16 | <b>ErrorCodeExt: extended error code.</b> Read-write; updated-by-hardware. Cold reset: 0. See <a href="#">MSR0000_0401</a> [ErrorCodeExt]. See <a href="#">Table 228</a> for expected values.                  |
| 15:0  | <b>ErrorCode: error code.</b> Read-write; Updated-by-hardware. Cold reset: 0. See <a href="#">2.15.1.5 [Error Code]</a> for details on decoding this field. See <a href="#">Table 228</a> for expected values. |

**Table 226: MBE, SBU, and SBC Definitions**

| Term       | Definition                                                                                                                         |
|------------|------------------------------------------------------------------------------------------------------------------------------------|
| <b>MBE</b> | Multi-bit ECC error, uncorrected.                                                                                                  |
| <b>SBU</b> | Single-bit ECC error, not-corrected. There are some implementation specific conditions when a single bit error is not correctable. |
| <b>SBC</b> | Single-bit ECC error is detected and correctable.                                                                                  |

**Table 227: MC2 Error Descriptions**

| Error Type       | Error     | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | CTL <sup>3</sup> | CID <sup>2</sup> | EAC <sup>1</sup> |     |    |                    |    |    |        |    |    |                |          |   |   |
|------------------|-----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|------------------|------------------|-----|----|--------------------|----|----|--------|----|----|----------------|----------|---|---|
| System Read Data | L2Tlb     | An error occurred during an attempted read of data from the NB. Possible reasons include master abort, target abort, and receipt of read data error for TLB. Error Action <sup>4</sup> : None.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | RdData           | A                | D                |     |    |                    |    |    |        |    |    |                |          |   |   |
|                  | Prefetch  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                  |                  |                  |     |    |                    |    |    |        |    |    |                |          |   |   |
|                  | Wcc       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                  |                  |                  |     |    |                    |    |    |        |    |    |                |          |   |   |
| TLB              | TlbPar    | Data parity error reading from TLB. Error Action <sup>4</sup> : Invalidate TLB entry.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | L2TlbData        | A                | D                |     |    |                    |    |    |        |    |    |                |          |   |   |
|                  | FillErr   | Poison data provided for TLB fill. Error Action <sup>4</sup> : None.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | L2TlbPoison      | A                | D                |     |    |                    |    |    |        |    |    |                |          |   |   |
| L2 Cache         | Prefetch  | Prefetcher request FIFO parity error. Error Action <sup>4</sup> : Invalidate entry (drop prefetch).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | L2Prefetch       | A                | D                |     |    |                    |    |    |        |    |    |                |          |   |   |
| L2 Cache         | FillEcc   | Fill ECC error on data fills.<br>CECC: Corrected data returned to destination; error remains in source.<br>UECC: Poison data returned to destination; error remains in source.<br><br>The data sources are indicated in LL field and affect what part of Way is valid:<br><table><tr><td><u>Source</u></td><td><u>LL</u></td><td><u>Way</u></td></tr><tr><td>WCC</td><td>L1</td><td>[1:0]. See Note 1.</td></tr><tr><td>L2</td><td>L2</td><td>[3:0].</td></tr><tr><td>NB</td><td>LG</td><td>-. See Note 2.</td></tr></table><br>Notes:<br>1. WCC: Indicates data corrupted in WCC or Fill Buffer.<br>2. NB: Note: Data from NB was sent either okay (good ECC) or already poisoned. Indicates data corrupted in Fill Buffer. | <u>Source</u>    | <u>LL</u>        | <u>Way</u>       | WCC | L1 | [1:0]. See Note 1. | L2 | L2 | [3:0]. | NB | LG | -. See Note 2. | FillData | A | D |
| <u>Source</u>    | <u>LL</u> | <u>Way</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                  |                  |                  |     |    |                    |    |    |        |    |    |                |          |   |   |
| WCC              | L1        | [1:0]. See Note 1.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                  |                  |                  |     |    |                    |    |    |        |    |    |                |          |   |   |
| L2               | L2        | [3:0].                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                  |                  |                  |     |    |                    |    |    |        |    |    |                |          |   |   |
| NB               | LG        | -. See Note 2.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                  |                  |                  |     |    |                    |    |    |        |    |    |                |          |   |   |

**Table 227: MC2 Error Descriptions**

| Error Type | Error   | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | CTL <sup>3</sup>  | CID <sup>2</sup> | EAC <sup>1</sup> |
|------------|---------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|------------------|------------------|
| L2 Cache   | FillPar | Fill parity error on instruction fills.<br><u>SubCase</u> <u>Description</u><br>NB->IC      NB to IC parity error: Error Action <sup>4</sup> :<br>Invalidate data and Nack request (IC<br>will re-request).<br>L2->IC      L2 to IC parity error: Error Action <sup>4</sup> :<br>Invalidate data and Nack request (IC<br>will re-request).<br>L2->LS,TLB      L2 to LS or TLB parity error: Error<br>Action <sup>4</sup> : Poison data returned to desti-<br>nation; error remains in source. | FillData          | A                | D                |
| L2 Cache   | PrqAddr | Post Retire Queue address parity error. Error Action <sup>4</sup> :<br><a href="#">Sync flood.</a>                                                                                                                                                                                                                                                                                                                                                                                            | PrqAddr           | A                | D                |
| L2 Cache   | PrqData | Post Retire Queue data parity error. Error Action <sup>4</sup> :<br>Poison line WCC or line sent to NB.                                                                                                                                                                                                                                                                                                                                                                                       | PrqData           | A                | D                |
| L2 Cache   | WccTag  | Write Coalescing Cache tag ECC error.<br><u>SubCase</u> <u>Error Action<sup>4</sup></u><br>UECC <a href="#">Sync flood.</a><br>CECC      Invalidate Wcc tag entry (cleans<br>error).                                                                                                                                                                                                                                                                                                          | WccAddr           | 0                | D                |
| L2 Cache   | WccData | WCC data ECC error.<br><u>SubCase</u> <u>Error Action<sup>4</sup></u><br>UECC      Poison copy in WCC.<br>CECC      Corrected copy in WCC.                                                                                                                                                                                                                                                                                                                                                    | WccData           | A                | D                |
| L2 Cache   | WcbData | WCB data parity error. Error Action <sup>4</sup> : Poison sent to<br>NB.                                                                                                                                                                                                                                                                                                                                                                                                                      | WcbData           | A                | D                |
| L2 Cache   | VbData  | VB data ECC or parity error.<br><u>SubCase</u> <u>Description</u><br>Par      Parity: Parity error indicated when<br>CECC and UECC are both clear.<br>Error Action <sup>4</sup> : Poison sent to NB.<br>UECC      Error Action <sup>4</sup> : Poison sent to NB.<br>CECC      Single-bit ECC error, corrected: Error<br>Action <sup>4</sup> : Corrected data sent to NB.                                                                                                                      | VbData            | 0                | D                |
| L2 Cache   | L2TagMH | Multiple hits on L2 tag. Error Action <sup>4</sup> : <a href="#">Sync flood.</a>                                                                                                                                                                                                                                                                                                                                                                                                              | L2TagMulti<br>Hit | 0                | D                |

**Table 227: MC2 Error Descriptions**

| Error Type | Error                                                                                                                | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | CTL <sup>3</sup> | CID <sup>2</sup> | EAC <sup>1</sup> |                                                          |      |                                                                             |      |                                                                                                                      |       |   |   |
|------------|----------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|------------------|------------------|----------------------------------------------------------|------|-----------------------------------------------------------------------------|------|----------------------------------------------------------------------------------------------------------------------|-------|---|---|
| L2 Cache   | L2Tag                                                                                                                | <p>A correctable or uncorrectable ECC error was seen in the L2 tag. The L2TagMH error signature supersedes the L2Tag error signature if they both occur for the same L2 tag read.</p> <table><thead><tr><th>SubCase</th><th>Description</th></tr></thead><tbody><tr><td>UECC</td><td>Error Action<sup>4</sup>: <a href="#">Sync flood</a>.</td></tr><tr><td>CECC</td><td>Error Action<sup>4</sup>: Correct error in array and retry the operation.</td></tr><tr><td>Hard</td><td>A hard correctable error (UC, CECC) was seen in the L2 tag. Error Action<sup>4</sup>: <a href="#">Sync flood</a>.</td></tr></tbody></table> | SubCase          | Description      | UECC             | Error Action <sup>4</sup> : <a href="#">Sync flood</a> . | CECC | Error Action <sup>4</sup> : Correct error in array and retry the operation. | Hard | A hard correctable error (UC, CECC) was seen in the L2 tag. Error Action <sup>4</sup> : <a href="#">Sync flood</a> . | L2Tag | 0 | D |
| SubCase    | Description                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                  |                  |                  |                                                          |      |                                                                             |      |                                                                                                                      |       |   |   |
| UECC       | Error Action <sup>4</sup> : <a href="#">Sync flood</a> .                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                  |                  |                  |                                                          |      |                                                                             |      |                                                                                                                      |       |   |   |
| CECC       | Error Action <sup>4</sup> : Correct error in array and retry the operation.                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                  |                  |                  |                                                          |      |                                                                             |      |                                                                                                                      |       |   |   |
| Hard       | A hard correctable error (UC, CECC) was seen in the L2 tag. Error Action <sup>4</sup> : <a href="#">Sync flood</a> . |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                  |                  |                  |                                                          |      |                                                                             |      |                                                                                                                      |       |   |   |
| L2 Cache   | XabAddr                                                                                                              | Transaction Address Buffer (XAB) parity error.This error is system fatal; memory coherence may have been affected. Error Action <sup>4</sup> : <a href="#">Sync flood</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                  | XabAddr          | A                | D                |                                                          |      |                                                                             |      |                                                                                                                      |       |   |   |
| L2 Cache   | PrbAddr                                                                                                              | Probe buffer address parity error. This error is system fatal; memory coherence may have been affected. Error Action <sup>4</sup> : <a href="#">Sync flood</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                             | PrbAddr          | 0                | D                |                                                          |      |                                                                             |      |                                                                                                                      |       |   |   |

1.

EAC: The error action is taken if detected for all CU errors. D=Error action taken if detected. E=Error action taken if MCA bank enabled.See [2.15.1.3 \[Error Detection, Action, Logging, and Reporting\]](#).

2.

CID: core ID. A=Error reported to the affected core. 0=Error reported to core 0 of the compute unit; see [2.15.1.3 \[Error Detection, Action, Logging, and Reporting\]](#).

3.

See [MSR0000\\_0408](#).

4.

Error Action: [Sync flood](#)=Take sync flood if PCC=1. None=No action other than that specified by MCA.

**Table 228: MC2 Error Signatures**

| Error Type       | Error Sub-Type | Sub    | ErrorC<br>odeExt | Error Code |           |   |      |         |                  | UC | ADDRV | PCC | Syndrome | Way              | CECC | UECC | Deferred | Poison |
|------------------|----------------|--------|------------------|------------|-----------|---|------|---------|------------------|----|-------|-----|----------|------------------|------|------|----------|--------|
|                  |                |        |                  | Type       | UU/<br>PP | T | RRRR | II/TT   | LL               |    |       |     |          |                  |      |      |          |        |
| TLB              | TlbPar         | -      | 00h              | TLB        | -         | - | -    | G       | L2               | 0  | 1     | 0   | -        | [2:0]            | 0    | 0    | 0        | 0      |
|                  | FillErr        | -      | 01h              |            |           |   |      |         |                  | 1  |       |     |          | -                |      |      |          | 1      |
| System Read Data | TLB            | -      | 00h              | BUS        | SRC       | 0 | RD   | MEM /IO | L2               | 1  | 1     | 0   | -        | -                | 0    | 0    | 0        | 0      |
|                  | Prefetch       |        | 01h              |            |           |   |      | MEM     | L2               | 0  |       |     |          |                  |      |      |          | 1      |
|                  | Wcc            |        | 02h              |            |           |   |      | DWR     | L1               | 1  |       |     |          |                  |      |      |          | 0      |
| L2 Cache         | FillEcc        | -      | 04h              | MEM        | -         | - | DRD  | D       | See <sup>1</sup> | 0  | 1     | 0   | [8:0]    | See <sup>1</sup> | 0/1  | 0/1  | 0/1      | 0      |
| L2 Cache         | FillPar        | NB->IC | 05h              | MEM        | -         | - | IRD  | I       | LG               | 0  | 0     | 0   | -        | -                | 0    | 0    | 0        | 0      |
|                  |                |        |                  |            |           |   |      | L2      |                  |    |       |     |          |                  |      |      |          |        |
|                  |                | L2->IC |                  |            |           |   |      | DRD     | D                | 0  | 1     | 0   |          | [3:0]            |      |      | 1        |        |

**Table 228: MC2 Error Signatures**

| Error Type | Error Sub-Type | Sub  | Error Code Ext | Error Code |       |   |              |       |    | UC  | ADDR | PCC | Syndrome | Way   | CECC | UECC | Deferred | Poison |
|------------|----------------|------|----------------|------------|-------|---|--------------|-------|----|-----|------|-----|----------|-------|------|------|----------|--------|
|            |                |      |                | Type       | UU/PP | T | RRRR         | II/TT | LL |     |      |     |          |       |      |      |          |        |
| L2 Cache   | Prefetch       | -    | 06h            | MEM        | -     | - | Prefetch     | D     | L2 | 0   | 1    | 0   | -        | -     | 0    | 0    | 0        | 0      |
|            | PrqAddr        | -    | 07h            |            |       |   | DWR          | D     | L1 | 1   | 0    | 1   | -        | -     | 0    | 0    | 0        | 0      |
|            | PrqData        | -    | 08h            |            |       |   |              |       |    | 0   |      | 0   |          |       |      | 1    |          |        |
| L2 Cache   | WccTag         | -    | 09h            | MEM        | -     | - | DWR          | D     | L1 | 0/1 | 1    | UC  | [11:0]   | [1:0] | 0/1  | 0/1  | 0        | 0      |
|            | WccData        | -    | 0Ah            |            |       |   |              |       | L1 | 0   | 1    | 0   | [8:0]    | [1:0] | 0/1  | 0/1  | 0/1      | 0      |
|            | WcbData        | -    | 0Bh            |            |       |   |              |       | LG | 0   |      | 0   | -        | -     | 0    | 0    | 1        |        |
| L2 Cache   | VbData         | Par  | 0Ch            | MEM        | -     | - | Probe, Evict | I     | L2 | 0   | 0    | 0   | -        | -     | 0    | 0    | 1        | 0      |
|            |                | ECC  |                |            |       |   |              | D     |    |     |      |     | [8:0]    |       | 0/1  | 0/1  |          |        |
| Tag        | L2Tag          | -    | 10h            | MEM        | -     | - | GEN          | G     | L2 | 0/1 | 1    | UC  | [7:0]    | [3:0] | 0/1  | 0/1  | 0        | 0      |
|            |                | Hard | 11h            |            |       |   |              |       |    | 1   | 1    | 1   | -        | [3:0] | 0    | 0    | 0        | 0      |
|            | L2Tag          | -    | 12h            |            |       |   |              |       |    | 1   | 1    | 1   | -        | -     | 0    | 0    | 0        | 0      |
|            |                | -    | 13h            |            |       |   |              |       |    |     |      |     |          |       |      |      |          |        |
|            | XabAddr        | -    | 13h            |            |       |   |              |       |    |     |      |     |          |       |      |      |          |        |
|            | PrbAddr        | -    | 14h            |            |       |   | Probe        |       |    |     |      |     |          |       |      |      |          |        |

1. LL and Way are specified in [Table 227](#).

**MSR0000\_040A MC2 Machine Check Address (MC2\_ADDR)**

Read-write; Updated-by-hardware. Cold reset: 0000\_0000\_0000\_0000h. See [2.15.1 \[Machine Check Architecture\]](#). The following table defines the address register as a function of error type.

| Bits | Description                                                                    |
|------|--------------------------------------------------------------------------------|
| 63:0 | <b>ADDR</b> . Read-write; updated-by-hardware. See <a href="#">Table 229</a> . |

**Table 229: MC2 Address Register**

| Error Type             | Error Sub-Type | Bits  | Description                 |
|------------------------|----------------|-------|-----------------------------|
| System Read Data Error |                | 63:48 | Reserved                    |
|                        |                | 47:6  | <b>PhysAddr[47:6]</b> .     |
|                        |                | 5:0   | Reserved                    |
| TLB                    | TlbPar         | 63:7  | Reserved                    |
|                        |                | 6:0   | <b>Index[6:0]</b> .         |
|                        | FillErr        | 63:48 | Reserved                    |
|                        |                | 47:6  | <b>PhysAddr[47:6]</b> .     |
|                        |                | 5:0   | Reserved                    |
| L2 Cache               | Prefetch       | 63:5  | Reserved                    |
|                        |                | 4:0   | Prefetch FIFO read pointer. |

**Table 229: MC2 Address Register**

| Error Type | Error Sub-Type                           | Bits  | Description                                                                                                                                                                                                |
|------------|------------------------------------------|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| L2 Cache   | FillEcc, FillPar<br>(SubCase=L2->LS,TLB) | 63:48 | Reserved                                                                                                                                                                                                   |
|            |                                          | 47:3  | <b>PhysAddr[47:3]</b> .                                                                                                                                                                                    |
|            |                                          | 2:0   | Reserved                                                                                                                                                                                                   |
| L2 Cache   | WccTag,<br>WccData                       | 63:10 | Reserved                                                                                                                                                                                                   |
|            |                                          | 9:6   | <b>Index[9:6]</b> .                                                                                                                                                                                        |
|            |                                          | 5:0   | Reserved                                                                                                                                                                                                   |
| L2 Cache   | WcbData                                  | 63:48 | Reserved                                                                                                                                                                                                   |
|            |                                          | 47:3  | <b>PhysAddr[47:3]</b> .                                                                                                                                                                                    |
|            |                                          | 2     | Reserved                                                                                                                                                                                                   |
|            |                                          | 1:0   | Index[1:0].                                                                                                                                                                                                |
| Tag        | L2Tag,<br>L2TagMH                        | 63:17 | Reserved                                                                                                                                                                                                   |
|            |                                          | 16:6  | <b>PhysAddr[16:6]</b> .<br><div> <div>Bits</div> <div>Description</div> </div> 1 MB PhysAddr[15:6] valid; [16] Reserved.<br>2 MB PhysAddr[16:6] valid<br>See <a href="#">CPUID Fn8000_0006_ECX[L2Size]</a> |
|            |                                          | 5:0   | Reserved                                                                                                                                                                                                   |
|            |                                          |       |                                                                                                                                                                                                            |
| Tag        | XabAddr                                  | 63:5  | Reserved                                                                                                                                                                                                   |
|            |                                          | 4:0   | XabIndex.                                                                                                                                                                                                  |
| Tag        | PrbAddr                                  | 63:4  | Reserved                                                                                                                                                                                                   |
|            |                                          | 3:0   | ProbeBufferIndex.                                                                                                                                                                                          |

**MSR0000\_040B MC2 Machine Check Miscellaneous (MC2\_MISC)**

Cold reset: 0000\_0000\_0000\_0000h.

See [2.15.1.7 \[Error Thresholding\]](#).

| Bits  | Description                                                                       |
|-------|-----------------------------------------------------------------------------------|
| 63    | <b>Valid.</b> See: <a href="#">MSR0000_0403[Valid]</a> .                          |
| 62    | <b>CntP: counter present.</b> See: <a href="#">MSR0000_0403[CntP]</a> .           |
| 61    | <b>Locked.</b> See: <a href="#">MSR0000_0403[Locked]</a> .                        |
| 60    | <b>IntP: Interrupt support present.</b> See: <a href="#">MSR0000_0403[IntP]</a> . |
| 59:56 | Reserved.                                                                         |
| 55:52 | <b>LvtOffset: LVT offset.</b> See: <a href="#">MSR0000_0403[LvtOffset]</a> .      |
| 51    | <b>CntEn: counter enable.</b> See: <a href="#">MSR0000_0403[CntEn]</a> .          |
| 50:49 | <b>IntType: interrupt type.</b> See: <a href="#">MSR0000_0403[IntType]</a> .      |
| 48    | <b>Ovrflw: overflow.</b> See: <a href="#">MSR0000_0403[Ovrflw]</a> .              |
| 47:44 | Reserved.                                                                         |
| 43:32 | <b>ErrCnt: error counter.</b> See: <a href="#">MSR0000_0403[ErrCnt]</a> .         |

|       |                                                                                                         |
|-------|---------------------------------------------------------------------------------------------------------|
| 31:24 | <b>BlkPtr: Block pointer for additional MISC registers.</b> See: <a href="#">MSR0000_0403</a> [BlkPtr]. |
| 23:0  | Reserved.                                                                                               |

### MSR0000\_040C MC3 Machine Check Control (MC3\_CTL)

Reset: 0000\_0000\_0000\_0000h. Read-only.

| Bits | Description |
|------|-------------|
| 63:0 | Unused.     |

### MSR0000\_040D MC3 Machine Check Status (MC3\_STATUS)

Reset: 0. See [MSRC001\\_0015](#)[McStatusWrEn].

| Bits | Description |
|------|-------------|
| 63:0 | Reserved.   |

### MSR0000\_040E MC3 Machine Check Address (MC3\_ADDR)

Reset: 0000\_0000\_0000\_0000h. Read-only.

| Bits | Description |
|------|-------------|
| 63:0 | Reserved.   |

### MSR0000\_040F MC3 Machine Check Miscellaneous (MC3\_MISC)

Reset: 0000\_0000\_0000\_0000h. Read-only.

| Bits | Description |
|------|-------------|
| 63:0 | Reserved.   |

### MSR0000\_0410 MC4 Machine Check Control (MC4\_CTL)

Read-write; **Not-same-for-all**. Reset: 0000\_0000\_0000\_0000h.

[MSR0000\\_0410](#)[31:0] is an alias of [D18F3x40](#), which is accessible through PCI configuration space. Only one of these registers exists in multi-core devices; see [3.1.1 \[Northbridge MSRs In Multi-Core Products\]](#).

Accessibility of this register by non-NBC cores is affected by [D18F3x44](#)[NbMcaToMstCpuEn].

See [D18F3x44 \[MCA NB Configuration\]](#) for further NB MCA configuration controls. See [2.15.1 \[Machine Check Architecture\]](#) for a general description of the machine check architecture. See [MSRC001\\_0048 \[NB Machine Check Control Mask \(MC4\\_CTL\\_MASK\)\]](#) for the corresponding error mask register.

| Bits  | Description                                                                                                |
|-------|------------------------------------------------------------------------------------------------------------|
| 63:32 | Unused.                                                                                                    |
| 31    | <b>McaCpuDatErrEn: Compute Unit data error.</b> 1=Enables MCA reporting of CPU data errors sent to the NB. |
| 30    | Unused.                                                                                                    |

|       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 29:28 | Unused.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 27    | Unused.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 26    | <b>NbArrayParEn: northbridge array parity error reporting enable.</b> IF ((D18F4x118[NbPwrGate1]    D18F4x118[NbPwrGate0]    D18F4x11C[NbPwrGate2])=1) THEN BIOS: 1. ENDIF. 1=Enables reporting of parity errors in the NB arrays.                                                                                                                                                                                                                                                                                                                        |
| 25    | <b>UsPwDatErrEn: upstream data error enable.</b> Read-write. 1=Enables MCA reporting of upstream posted writes in which the EP bit is set.                                                                                                                                                                                                                                                                                                                                                                                                                |
| 24:18 | Unused.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 17    | <b>CpPktDatEn: completion packet error reporting enable.</b> Read-write. 1=Enables MCA reporting of completion packets with the EP bit set.                                                                                                                                                                                                                                                                                                                                                                                                               |
| 16    | <b>NbIntProtEn: northbridge internal bus protocol error reporting enable.</b> Read-write. 1=Enables MCA reporting of protocol errors detected on the northbridge internal bus. When possible, this enable should be cleared before initiating a warm reset to avoid logging spurious errors due to RESET_L signal skew.                                                                                                                                                                                                                                   |
| 15:13 | Unused.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 12    | <b>WDTRptEn: watchdog timer error reporting enable.</b> 1=Enables MCA reporting of watchdog timer errors. The watchdog timer checks for NB system accesses for which a response is expected but no response is received. See D18F3x44 [MCA NB Configuration] for information regarding configuration of the watchdog timer duration. This bit does not affect operation of the watchdog timer in terms of its ability to complete an access that would otherwise cause a system hang. This bit only affects whether such errors are reported through MCA. |
| 11    | <b>AtomicRMWEn: atomic read-modify-write error reporting enable.</b> 1=Enables MCA reporting of atomic read-modify-write (RMW) commands received from an IO link. Atomic RMW commands are not supported. An atomic RMW command results in a link error response being generated back to the requesting IO device. The generation of the link error response is not affected by this bit.                                                                                                                                                                  |
| 10    | Unused.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 9     | <b>TgtAbortEn: target abort error reporting enable.</b> 1=Enables MCA reporting of target aborts to a link. The NB returns an error response back to the requestor with any associated data all 1s independent of the state of this bit.                                                                                                                                                                                                                                                                                                                  |
| 8     | <b>MstrAbortEn: master abort error reporting enable.</b> 1=Enables MCA reporting of master aborts to a link. The NB returns an error response back to the requestor with any associated data all 1s independent of the state of this bit.                                                                                                                                                                                                                                                                                                                 |
| 7:6   | Unused.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 5     | <b>SyncPktEn: link sync packet error reporting enable.</b> 1=Enables MCA reporting of link-defined sync error packets detected on link. The NB floods its outgoing link with sync packets after detecting a sync packet on the incoming link independent of the state of this bit.                                                                                                                                                                                                                                                                        |
| 4:2   | Unused.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 1     | <b>UECCEn: uncorrectable ECC error reporting enable.</b> 1=Enables MCA reporting of DDR3 DRAM uncorrectable ECC errors which are detected in the NB. In some cases data may be forwarded to the core prior to checking ECC in which case the check takes place in one of the other error reporting banks.                                                                                                                                                                                                                                                 |
| 0     | <b>CECCEn: correctable ECC error reporting enable.</b> 1=Enables MCA reporting of DDR3 DRAM correctable ECC errors which are detected in the NB.                                                                                                                                                                                                                                                                                                                                                                                                          |

**MSR0000\_0411 MC4 Machine Check Status (MC4\_STATUS)**

Not-same-for-all. Cold reset: 0000\_0000\_0000\_0000h.

MSR0000\_0411[63:32] is an alias of D18F3x4C, and MSR0000\_0411[31:0] is an alias of D18F3x48. Only one of these registers exists in multi-core devices; see 3.1.1 [Northbridge MSRs In Multi-Core Products]. Accessibility of this register by non-NBC cores is affected by D18F3x44[NbMcaToMstCpuEn]. See MSRC001\_0015[McStatusWrEn] for information on writing to this register. See 2.15.1 [Machine Check Architecture] for machine check architecture background.

Table 230 describes each error type. Table 231 and Table 232 describe the error codes and status register settings for each error type.

| Bits  | Description                                                                                                                                                                                                                                                                                          |
|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 63    | <b>Val: valid.</b> See: MSR0000_0401[Val].                                                                                                                                                                                                                                                           |
| 62    | <b>Overflow: error overflow.</b> See: MSR0000_0401[Overflow].                                                                                                                                                                                                                                        |
| 61    | <b>UC: error uncorrected.</b> See: MSR0000_0401[UC].                                                                                                                                                                                                                                                 |
| 60    | <b>En: error enable.</b> See: MSR0000_0401[En].                                                                                                                                                                                                                                                      |
| 59    | <b>MiscV: miscellaneous error register valid.</b><br>See: MSR0000_0401[MiscV]. 1=Valid thresholding in MSR0000_0413 or MSRC000_0408.                                                                                                                                                                 |
| 58    | <b>AddrV: error address valid.</b> See: MSR0000_0401[AddrV].                                                                                                                                                                                                                                         |
| 57    | <b>PCC: processor context corrupt.</b> See: MSR0000_0401[PCC].                                                                                                                                                                                                                                       |
| 56    | <b>ErrCoreIdVal: error core ID is valid.</b> Read-write; set-by-hardware. 1=The ErrCoreId field is valid.                                                                                                                                                                                            |
| 55    | Reserved.                                                                                                                                                                                                                                                                                            |
| 54:47 | <b>Syndrome[7:0].</b> Read-write. Syndrome[15:0] = {Syndrome[15:8], Syndrome[7:0]}. The syndrome bits when an ECC error is detected. See Table 232 Valid Syndrome column for which bits are valid for each error.                                                                                    |
| 46    | <b>CECC: correctable ECC error.</b> Read-write; Updated-by-hardware. 1=The error was a correctable ECC error according to the restrictions of the ECC algorithm. UC indicates whether the error was actually corrected by the processor.                                                             |
| 45    | <b>UECC: uncorrectable ECC error.</b> Read-write; Updated-by-hardware. 1=The error was an uncorrectable ECC error according to the restrictions of the ECC algorithm. UC indicates whether the error was actually corrected by the processor.                                                        |
| 44    | <b>Deferred: deferred error.</b> Read-write; Updated-by-hardware. 1=A deferred error was created. A deferred error is the result of an uncorrectable data error which did not immediately cause a processor exception; the data is poisoned and an exception is deferred until the data is consumed. |
| 43:42 | Reserved.                                                                                                                                                                                                                                                                                            |
| 41    | <b>SubLink: sublink.</b> Read-write; set-by-hardware. For errors associated with a link, this bit indicates if the error was associated with the upper or lower byte of the link. 0=Sublink [7:0]. 1=Sublink [15:8].                                                                                 |
| 40    | <b>Scrub: error detected on a scrub.</b> Read-write; Set-by-hardware.                                                                                                                                                                                                                                |
| 39:37 | Reserved.                                                                                                                                                                                                                                                                                            |
| 36    | <b>Link.</b> Read-write; set-by-hardware. For errors associated with a link, this field indicates that the link was associated with the error.                                                                                                                                                       |



|       |                                                                                                                                                                                                                                                                                                   |
|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 35:32 | <b>ErrCoreId: error associated with core N.</b> Read-write; updated-by-hardware. When ErrCoreIdVal=1 this field indicates which core within the processor is associated with the error; Otherwise this field is reserved. All values greater than <a href="#">D18F5x84</a> [CmpCap] are reserved. |
| 31:24 | Reserved.                                                                                                                                                                                                                                                                                         |
| 23:21 | Reserved.                                                                                                                                                                                                                                                                                         |
| 20:16 | <b>ErrorCodeExt: extended error code.</b> Read-write; Updated-by-hardware. See <a href="#">MSR0000_0401</a> [ErrorCodeExt]. See <a href="#">Table 231</a> for values.                                                                                                                             |
| 15:0  | <b>ErrorCode: error code.</b> Read-write; Updated-by-hardware. See <a href="#">2.15.1.5 [Error Code]</a> .                                                                                                                                                                                        |

**Table 230: MC4 Error Descriptions**

| Error Type      | Description                                                                                                                                                                                                                                                                                                          | CTL <sup>1</sup>                   | ETG <sup>2</sup> | EAC <sup>4</sup> |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------|------------------|------------------|
| Sync Error      | Link-defined sync error packets detected on link. The NB floods its outgoing links with sync packets after detecting a sync packet on an incoming link independent of the state of the control bits.                                                                                                                 | SyncPktEn                          | L                | D                |
| Master Abort    | Master abort seen as result of link operation. Reasons for this error include requests to non-existent addresses. The NB returns an error response back to the requestor with any associated data all 1s independent of the state of the control bit.                                                                | MstrAbortEn                        | L                | D                |
| Target Abort    | Target abort seen as result of link operation. The NB returns an error response back to the requestor with any associated data all 1s independent of the state of the control bit.                                                                                                                                   | TgtAbortEn                         | L                | D                |
| RMW Error       | An atomic read-modify-write (RMW) command was received from an IO link. Atomic RMW commands are not supported. An atomic RMW command results in a link error response being generated back to the requesting IO device. The generation of the link error response is not affected by the control bit.                | AtomicRMW<br>En                    | L                | D                |
| WDT Error       | NB WDT timeout due to lack of progress. The NB WDT monitors transaction completions. A transaction that exceeds the programmed time limit reports errors via the MCA. The cause of error may be another node or device which failed to respond.                                                                      | WDTRptEn                           | L                | D                |
| DRAM ECC Error  | A DRAM ECC error detected.                                                                                                                                                                                                                                                                                           | CECCEn,<br>UECCEn                  | D                | D                |
| Link Data Error | Data error detected on link.<br>If enabled for reporting and the request is sourced from a core, then PCC is set. (If not enabled for reporting, PCC is not set. If configured to allow an error response to be returned to the core, this could allow error containment to a scope smaller than the entire system.) | McaUsPwDat<br>ErrEn,<br>CpPktDatEn | L                | D                |

**Table 230: MC4 Error Descriptions**

| Error Type                                                                                                                                                                                                                                                                                                                                                                                                                   | Description                                                                                                                                                                                                                                                                                                                                                                                                                              | CTL <sup>1</sup> | ETG <sup>2</sup> | EAC <sup>4</sup> |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|------------------|------------------|
| Protocol Error                                                                                                                                                                                                                                                                                                                                                                                                               | Protocol error detected by link. These errors are distinguished from each other by the value in <a href="#">MSR0000_0412</a> [ErrAddr]. See <a href="#">Table 234</a> .<br><br>For protocol errors, the system cannot continue operation. Protocol errors can be caused by other subcomponents than the one reporting the error. For diagnosis, collect and examine MCA registers from other banks, cores, and processors in the system. | NbIntProtEn      | L <sup>3</sup>   | D                |
| NB Array Error                                                                                                                                                                                                                                                                                                                                                                                                               | A parity error was detected in the NB internal arrays.                                                                                                                                                                                                                                                                                                                                                                                   | NbArrayParEn     | -                | D                |
| Compute Unit Data Error                                                                                                                                                                                                                                                                                                                                                                                                      | NB received a data error from a core and this error could not be contained. For the cause of the data error, examine the core MCA registers for deferred errors. This error may occur for the following types of data writes: <ul style="list-style-type: none"> <li>• APIC</li> <li>• Configuration space (IO and MMIO)</li> </ul> For these errors, sync flood will occur if <a href="#">D18F3x180</a> [SyncFloodOnCpuLeakErr] is set. | McaCpuDataErrEn  | -                | D                |
| <p>1. CTL: See <a href="#">MSR0000_0410</a>.</p> <p>2. ETG: error threshold group. See <a href="#">2.15.1.7 [Error Thresholding]</a>.</p> <ul style="list-style-type: none"> <li>• L=Link.</li> <li>• D=DRAM.</li> </ul> <p>3. The error thresholding group is Link if link protocol error; none for non-link protocol error.</p> <p>4. EAC: D=Error action taken if detected. E=Error action taken if MCA bank enabled.</p> |                                                                                                                                                                                                                                                                                                                                                                                                                                          |                  |                  |                  |

The NB is capable of reporting the following errors:

**Table 231: MC4 Error Signatures, Part 1**

| Error Type              | ErrorCode-Ext | Error Code |         |   |           |                     |    |
|-------------------------|---------------|------------|---------|---|-----------|---------------------|----|
|                         |               | Type       | PP      | T | RRRR      | II/TT               | LL |
| Reserved                | 00h           | -          | -       | - | -         | -                   | -  |
| Reserved                | 01h           | -          | -       | - | -         | -                   | -  |
| Sync Error              | 02h           | BUS        | OBS     | 0 | GEN       | GEN                 | LG |
| Mst Abort               | 03h           | BUS        | SRC/OBS | 0 | RD/WR     | MEM/IO <sup>1</sup> | LG |
| Tgt Abort               | 04h           | BUS        | SRC/OBS | 0 | RD/WR     | MEM/IO <sup>1</sup> | LG |
| RMW Error               | 06h           | BUS        | OBS     | 0 | GEN       | IO                  | LG |
| WDT Error               | 07h           | BUS        | GEN     | 1 | GEN       | GEN                 | LG |
| ECC Error               | 08h           | BUS        | SRC/RES | 0 | RD/WR     | MEM                 | LG |
| Link Data Error         | 0Ah           | BUS        | SRC/OBS | 0 | RD/WR/DWR | MEM/IO              | LG |
| NB Protocol Error       | 0Bh           |            | OBS     | 0 | GEN       | GEN                 | LG |
| NB Array Error          | 0Ch           |            | OBS     | 0 | GEN       | GEN                 | LG |
| Compute Unit Data Error | 19h           | MEM        | -       | - | WR        | Data                | LG |

**Table 231: MC4 Error Signatures, Part 1**

| Error Type                                                                                                                               | ErrorCode-Ext | Error Code |    |   |      |       |    |
|------------------------------------------------------------------------------------------------------------------------------------------|---------------|------------|----|---|------|-------|----|
|                                                                                                                                          |               | Type       | PP | T | RRRR | II/TT | LL |
| 1. Indicates the type of link attached to the reporting NB, not the instruction type. MEM indicates coherent link, IO indicates IO link. |               |            |    |   |      |       |    |

**Table 232: MC4 Error Signatures, Part 2**

| Error Type              | UC                      | AddrV            | PCC                                  | Syndrome Valid | CECC                    | UECC                    | Deferred | Scrub | Link | Err CoreId |
|-------------------------|-------------------------|------------------|--------------------------------------|----------------|-------------------------|-------------------------|----------|-------|------|------------|
| Sync Error              | 1                       | 0                | 1                                    | -              | 0                       | 0                       | 0        | 0     | Y    | -          |
| Mst Abort               | 1                       | 1                | Core <sup>10</sup>                   | -              | 0                       | 0                       | 0        | 0     | Y    | Y          |
| Tgt Abort               | 1                       | 1                | Core <sup>10</sup>                   | -              | 0                       | 0                       | 0        | 0     | Y    | Y          |
| RMW Error               | 1                       | 1                | 0                                    | -              | 0                       | 0                       | 0        | 0     | Y    | -          |
| WDT Error               | 1                       | 0 <sup>1</sup>   | 1                                    | -              | 0                       | 0                       | 0        | 0     | -    | -          |
|                         |                         | 1 <sup>2</sup>   |                                      |                |                         |                         |          |       |      |            |
| ECC Error               | MS <sup>6</sup>         | 1                | MS <sup>6</sup> & Core <sup>12</sup> | 15:0           | ~MS  Hist <sup>13</sup> | ~MS  Hist <sup>13</sup> | 0        | 1/0   | -    | -          |
| Link Data Error         | ~Deferred <sup>11</sup> | 1                | 0                                    | -              | 0                       | 0                       | 0/1      | 0     | Y    | -          |
| NB Protocol Error       | 1                       | 1/0 <sup>2</sup> | 1                                    | -              | 0                       | 0                       | 0        | 0     | Y    | -          |
| NB Array Error          | ~Deferred <sup>11</sup> | 1 <sup>4</sup>   | ~Deferred <sup>11</sup>              | -              | 0                       | 0                       | 0/1      | 0     | -    | -          |
| Compute Unit Data Error | 1                       | 0                | 1                                    | -              | 0                       | 0                       | 0        | 0     | -    | Y          |

1. See Table 238 [Format of MSR0000\_0412[ErrAddr[47:1]] for Watchdog Timer Errors].

2. See Table 234 [Format of MSR0000\_0412[ErrAddr[47:1]] for Protocol Errors].

3. See Table 237 [Valid Values for ArrayErrorType].

4. MS: multi-symbol. 1=Multi-symbol. 0=Not multi-symbol.

5. Core: source is core. 1=Source is core. 0=Source is not core.

6. Deferred: error is deferred. 1=Error is deferred. 0=Error is not deferred.

7. Hist: Error was detected by the hardware-managed history scheme.

### MSR0000\_0412 MC4 Machine Check Address (MC4\_ADDR)

IF (D18F3x44[NbMcaToMstCpuEn] && !NBC) THEN RAZ; Per-node; not-same-for-all. ELSE Read-write; Per-node; not-same-for-all. ENDIF. Cold reset: 0000\_0000\_0000\_0000h. See 2.15.1 [Machine Check Architecture]. MSR0000\_0412[31:0] is an alias of D18F3x50. MSR0000\_0412[63:32] is an alias of D18F3x54.

Only one of these registers exists in multi-core devices; see 3.1.1 [Northbridge MSRs In Multi-Core Products]. ErrAddr[47:1] carries supplemental information associated with a machine check error, generally the address being accessed. Accessibility of this register by non-NBC cores is affected by

[D18F3x44\[NbMcaToMstCpuEn\]](#). The format of [ErrAddr\[47:1\]](#) is a function of [MSR0000\\_0411\[ErrorCodeExt\]](#); See [ErrAddr\[47:1\]](#).

| Bits  | Description                                                                                                                                                                                                                                                                                                              |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 63:48 | Reserved. Value: 00h.                                                                                                                                                                                                                                                                                                    |
| 47:32 | <b>ErrAddr[47:32]: Error Address Bits[47:32]</b> . See: <a href="#">ErrAddr[31:1]</a> .                                                                                                                                                                                                                                  |
| 31:1  | <b>ErrAddr[31:1]: Error Address Bits[31:1]</b> . <a href="#">ErrAddr[47:0]</a> = { <a href="#">MSR0000_0412</a> [ <a href="#">ErrAddr[47:32]</a> ], <a href="#">MSR0000_0412</a> [ <a href="#">ErrAddr[31:1]</a> ], <a href="#">MSR0000_0412</a> [ <a href="#">ErrAddr[0]</a> ]} .See the tables below for the encoding. |
| 0     | <b>ErrAddr[0]: Error Address Bit[0]</b> .                                                                                                                                                                                                                                                                                |

The register format depends on the type of error being logged:

- Protocol errors contain the error reason code, may contain the physical address, and are formatted according to [Table 234](#).
- NB array errors indicate the array in error, and are formatted according to [Table 236](#).
- NB Watchdog timer errors depend on the mode selected by [D18F3x180\[McaLogErrAddrWdtErr\]](#), and the format is indicated by [D18F3x4C\[AddrV\]](#). If [D18F3x4C\[AddrV\]](#) is indicated, errors are formatted according to [Table 233](#). If [D18F3x4C\[AddrV\]](#) is not indicated, errors are formatted according to [Table 238](#).
- All other NB errors which indicate [D18F3x4C\[AddrV\]](#) are formatted according to [Table 233](#).

Table 233: Format of [MSR0000\\_0412](#)[[ErrAddr\[47:1\]](#)] for All Other Errors

| Bits | Description             |
|------|-------------------------|
| 47:1 | <b>PhysAddr[47:1]</b> . |

Table 234: Format of [MSR0000\\_0412](#)[[ErrAddr\[47:1\]](#)] for Protocol Errors

| Bits | Description                                                                                                        |
|------|--------------------------------------------------------------------------------------------------------------------|
| 47:6 | <b>PhysAddr[47:6]</b> . Valid of ( <a href="#">MSR0000_0411</a> [ <a href="#">AddrV</a> ]==1); otherwise reserved. |
| 5:1  | <b>ProtocolErrorType</b> . See <a href="#">Table 235 [Valid Values for ProtocolErrorType]</a> .                    |

**Table 235: Valid Values** for ProtocolErrorType

| Bits | Description                                                                                  |
|------|----------------------------------------------------------------------------------------------|
| 00h  | Link: SRQ Read Response without matching request                                             |
| 01h  | Link: Probe Response without matching request                                                |
| 02h  | Link: TgtDone without matching request                                                       |
| 03h  | Link: TgtStart without matching request                                                      |
| 04h  | Link: Command buffer overflow                                                                |
| 05h  | Link: Data buffer overflow                                                                   |
| 06h  | Link: Link retry packet count acknowledge overflow                                           |
| 07h  | Link: Data command in the middle of a data transfer                                          |
| 08h  | Link: Link address extension command followed by a packet other than a command with address. |
| 09h  | Link: A specific coherent-only packet from a CPU was issued to an IO link.                   |

**Table 235: Valid Values** for ProtocolErrorType

| Bits    | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|---------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 0Ah     | Link: A command with invalid encoding was received. This error occurs when: <ol style="list-style-type: none"> <li>Any invalid command is received (including a command with no valid encoding or a coherent link command over an IO link or vice versa) while not in retry mode.</li> <li>Any illegal command is received in which the CRC is correct while in retry mode (including any upstream broadcast command (link command encoding = 11101xb)).</li> </ol> |
| 0Bh     | Link: Link CTL deassertion occurred when a data phase was not pending. This error condition may only occur when error-retry mode is not enabled (if it is enabled, this condition triggers a retry).                                                                                                                                                                                                                                                                |
| 0Fh-0Ch | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 1Fh-10h | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                            |

Table 236: Format of [MSR0000\\_0412](#)[ErrAddr[47:1]] for NB Array Errors

| Bits | Description                                                                               |
|------|-------------------------------------------------------------------------------------------|
| 47:6 | Reserved.                                                                                 |
| 5:1  | <b>ArrayErrorType</b> . See <a href="#">Table 237 [Valid Values for ArrayErrorType]</a> . |

Table 237: **Valid Values** for ArrayErrorType

| Bits    | Description                                    |
|---------|------------------------------------------------|
| 00h     | SRA: System request address.                   |
| 01h     | SRD: System request data.                      |
| 02h     | SPB: System packet buffer.                     |
| 03h     | MCD: Memory controller data.                   |
| 04h     | MPB: Memory packet buffer.                     |
| 05h     | LPB0: Link 0 packet buffer.                    |
| 08h-06h | Reserved.                                      |
| 09h     | MPBC: Memory controller command packet buffer. |
| 0Ah     | MCDBM: Memory controller byte mask.            |
| 0Bh     | MCACAM: Memory controller address array.       |
| 0Ch     | DMAP: Extended DRAM address map.               |
| 0Dh     | MMAPI: Extended MMIO address map.              |
| 0Eh     | X86MAP: Extended PCI/IO address map.           |
| 0Fh     | CFGMAP: Extended config address map.           |
| 17h-10h | Reserved.                                      |
| 18h     | SRIMCTRTE: SRI/MCT extended routing table.     |
| 1Ch-19h | Reserved                                       |
| 1Dh     | TCB: TCB array.                                |
| 1Fh-1Eh | Reserved                                       |

**Table 238:** Format of [MSR0000\\_0412](#)[ErrAddr[47:1]] for Watchdog Timer Errors

| Bits    | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |      |             |         |                |         |               |     |                   |         |          |     |                    |         |          |         |                                                                                        |
|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|---------|----------------|---------|---------------|-----|-------------------|---------|----------|-----|--------------------|---------|----------|---------|----------------------------------------------------------------------------------------|
| 47:40   | <b>CoreId.</b> Indicates the core ID if the SourcePointer specifies Core.<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>07h-00h</td><td>CoreId</td></tr> <tr> <td>FFh-08h</td><td>Reserved</td></tr> </table>                                                                                                                                                                                                                                                                                                  | Bits | Description | 07h-00h | CoreId         | FFh-08h | Reserved      |     |                   |         |          |     |                    |         |          |         |                                                                                        |
| Bits    | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |      |             |         |                |         |               |     |                   |         |          |     |                    |         |          |         |                                                                                        |
| 07h-00h | CoreId                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |      |             |         |                |         |               |     |                   |         |          |     |                    |         |          |         |                                                                                        |
| FFh-08h | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |      |             |         |                |         |               |     |                   |         |          |     |                    |         |          |         |                                                                                        |
| 39:36   | <b>SystemResponseCount.</b> This field records unspecified, implementation-specific information.                                                                                                                                                                                                                                                                                                                                                                                                                                 |      |             |         |                |         |               |     |                   |         |          |     |                    |         |          |         |                                                                                        |
| 35:31   | <b>WaitCode.</b> records unspecified, implementation-specific information (all zeroes means no waiting condition).                                                                                                                                                                                                                                                                                                                                                                                                               |      |             |         |                |         |               |     |                   |         |          |     |                    |         |          |         |                                                                                        |
| 30      | <b>WaitForPostedWrite.</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |      |             |         |                |         |               |     |                   |         |          |     |                    |         |          |         |                                                                                        |
| 29:27   | <b>DestinationNode.</b> Records the Node ID of the node addressed by the transaction.                                                                                                                                                                                                                                                                                                                                                                                                                                            |      |             |         |                |         |               |     |                   |         |          |     |                    |         |          |         |                                                                                        |
| 26:25   | <b>DestinationUnit.</b><br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>Core</td></tr> <tr> <td>01b</td><td>Extended Core</td></tr> <tr> <td>10b</td><td>Memory Controller</td></tr> <tr> <td>11b</td><td>Host</td></tr> </table>                                                                                                                                                                                                                                                                    | Bits | Description | 00b     | Core           | 01b     | Extended Core | 10b | Memory Controller | 11b     | Host     |     |                    |         |          |         |                                                                                        |
| Bits    | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |      |             |         |                |         |               |     |                   |         |          |     |                    |         |          |         |                                                                                        |
| 00b     | Core                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |      |             |         |                |         |               |     |                   |         |          |     |                    |         |          |         |                                                                                        |
| 01b     | Extended Core                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |      |             |         |                |         |               |     |                   |         |          |     |                    |         |          |         |                                                                                        |
| 10b     | Memory Controller                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |      |             |         |                |         |               |     |                   |         |          |     |                    |         |          |         |                                                                                        |
| 11b     | Host                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |      |             |         |                |         |               |     |                   |         |          |     |                    |         |          |         |                                                                                        |
| 24:22   | <b>SourceNode.</b> Records the Node ID of the node originating the transaction.                                                                                                                                                                                                                                                                                                                                                                                                                                                  |      |             |         |                |         |               |     |                   |         |          |     |                    |         |          |         |                                                                                        |
| 21:20   | <b>SourceUnit.</b> (same encoding as Destination Unit)                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |      |             |         |                |         |               |     |                   |         |          |     |                    |         |          |         |                                                                                        |
| 19:15   | <b>SourcePointer.</b> Identifies crossbar source:<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00h</td><td>SRI HostBridge</td></tr> <tr> <td>03h-01h</td><td>Reserved</td></tr> <tr> <td>04h</td><td>Core. See CoreId.</td></tr> <tr> <td>07h-05h</td><td>Reserved</td></tr> <tr> <td>08h</td><td>Memory controller.</td></tr> <tr> <td>0Fh-09h</td><td>Reserved</td></tr> <tr> <td>1Fh-10h</td><td>Link. Link HH; sublink N (where N=0b for ganged links). All unused codes are reserved.</td></tr> </table> | Bits | Description | 00h     | SRI HostBridge | 03h-01h | Reserved      | 04h | Core. See CoreId. | 07h-05h | Reserved | 08h | Memory controller. | 0Fh-09h | Reserved | 1Fh-10h | Link. Link HH; sublink N (where N=0b for ganged links). All unused codes are reserved. |
| Bits    | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |      |             |         |                |         |               |     |                   |         |          |     |                    |         |          |         |                                                                                        |
| 00h     | SRI HostBridge                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |      |             |         |                |         |               |     |                   |         |          |     |                    |         |          |         |                                                                                        |
| 03h-01h | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |      |             |         |                |         |               |     |                   |         |          |     |                    |         |          |         |                                                                                        |
| 04h     | Core. See CoreId.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |      |             |         |                |         |               |     |                   |         |          |     |                    |         |          |         |                                                                                        |
| 07h-05h | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |      |             |         |                |         |               |     |                   |         |          |     |                    |         |          |         |                                                                                        |
| 08h     | Memory controller.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |      |             |         |                |         |               |     |                   |         |          |     |                    |         |          |         |                                                                                        |
| 0Fh-09h | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |      |             |         |                |         |               |     |                   |         |          |     |                    |         |          |         |                                                                                        |
| 1Fh-10h | Link. Link HH; sublink N (where N=0b for ganged links). All unused codes are reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                           |      |             |         |                |         |               |     |                   |         |          |     |                    |         |          |         |                                                                                        |
| 14:11   | <b>SrqEntryState.</b> Records unspecified, implementation-specific information (all zeroes means idle).                                                                                                                                                                                                                                                                                                                                                                                                                          |      |             |         |                |         |               |     |                   |         |          |     |                    |         |          |         |                                                                                        |
| 10:7    | <b>OpType.</b> Records unspecified, implementation-specific information.                                                                                                                                                                                                                                                                                                                                                                                                                                                         |      |             |         |                |         |               |     |                   |         |          |     |                    |         |          |         |                                                                                        |
| 6:1     | <b>LinkCommand.</b> When the NB WDT expires, the link command of the transaction that timed out is captured here. This field is encoded identically to the “Code” field for link transactions defined in the link specification.                                                                                                                                                                                                                                                                                                 |      |             |         |                |         |               |     |                   |         |          |     |                    |         |          |         |                                                                                        |

**MSR0000\_0413 NB Machine Check Misc 4 (DRAM Thresholding) 0 (MC4\_MISC0)**

[MSR0000\\_0413](#) is the first of the NB machine check miscellaneous registers. [MSR0000\\_0413](#) is associated with the DRAM error type. To see the remaining NB machine check miscellaneous registers, refer to [MSRC000\\_0408](#). Only one of these registers exists in multi-core devices; see [3.1.1 \[Northbridge MSRs In Multi-Core Products\]](#).

| Bits | Description |
|------|-------------|
|------|-------------|

| 63    | <b>Valid.</b> IF (D18F3x44[NbMcaToMstCpuEn] && !NBC) THEN RAZ; <b>Per-node</b> ; not-same-for-all. ELSIF (MSRC001_0015[McStatusWrEn]) THEN Read-write; <b>Per-node</b> ; not-same-for-all. ELSE Read-only; <b>Per-node</b> ; not-same-for-all. Reset: 1. ENDIF. 1=The CntP field is present.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |      |             |       |                    |       |                                                                |     |                                                                                                                                                          |     |          |
|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|-------|--------------------|-------|----------------------------------------------------------------|-----|----------------------------------------------------------------------------------------------------------------------------------------------------------|-----|----------|
| 62    | <b>CntP: counter present.</b> IF (D18F3x44[NbMcaToMstCpuEn] && !NBC) THEN RAZ; <b>Per-node</b> ; not-same-for-all. ELSIF (MSRC001_0015[McStatusWrEn]) THEN Read-write; <b>Per-node</b> ; not-same-for-all. ELSE Read-only; <b>Per-node</b> ; not-same-for-all. Reset: 1. ENDIF. 1=A valid threshold counter is present.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |      |             |       |                    |       |                                                                |     |                                                                                                                                                          |     |          |
| 61    | <b>Locked.</b> IF (D18F3x44[NbMcaToMstCpuEn] && !NBC) THEN RAZ; <b>Per-node</b> ; not-same-for-all. ELSIF (MSRC001_0015[McStatusWrEn]) THEN Read-write; <b>Per-node</b> ; not-same-for-all. ELSE Read-only; <b>Per-node</b> ; not-same-for-all. Reset: 0. ENDIF. BIOS: IF (IntType==10b) THEN 1. ELSE 0. ENDIF. 1=Writes to bits [55:32] of this register are ignored. Set by BIOS to indicate that this register is not available for OS use. When MSRC001_0015[McStatusWrEn] is set, MSR writes to this register update all bits, regardless of the state of the Locked bit.                                                                                                                                                                                                                                         |      |             |       |                    |       |                                                                |     |                                                                                                                                                          |     |          |
| 60:56 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |      |             |       |                    |       |                                                                |     |                                                                                                                                                          |     |          |
| 55:52 | <b>LvtOffset: LVT offset.</b> IF (D18F3x44[NbMcaToMstCpuEn] && !NBC) THEN RAZ; <b>Per-node</b> ; not-same-for-all. ELSIF (MSRC001_0015[McStatusWrEn]   ~MSR0000_0413[Locked]) THEN Read-write; <b>Per-node</b> ; not-same-for-all. ELSE Read-only; <b>Per-node</b> ; not-same-for-all. Reset: 0h. ENDIF. Specifies the address of the LVT entry in the APIC registers as follows: LVT address = (LvtOffset shifted left 4 bits) + 500h (see APIC[530:500]).<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>3h-0h</td><td>See APIC[530:500].</td></tr> <tr> <td>Fh-4h</td><td>Reserved</td></tr> </table>                                                                                                                                                                                              | Bits | Description | 3h-0h | See APIC[530:500]. | Fh-4h | Reserved                                                       |     |                                                                                                                                                          |     |          |
| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |      |             |       |                    |       |                                                                |     |                                                                                                                                                          |     |          |
| 3h-0h | See APIC[530:500].                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |      |             |       |                    |       |                                                                |     |                                                                                                                                                          |     |          |
| Fh-4h | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |      |             |       |                    |       |                                                                |     |                                                                                                                                                          |     |          |
| 51    | <b>CntEn: counter enable.</b> IF (D18F3x44[NbMcaToMstCpuEn] && !NBC) THEN RAZ; <b>Per-node</b> ; not-same-for-all. ELSIF (MSRC001_0015[McStatusWrEn]   ~Locked) THEN Read-write; <b>Per-node</b> ; not-same-for-all. ELSE Read-only; <b>Per-node</b> ; not-same-for-all. Reset: 0. ENDIF. 1=Count thresholding errors. See 2.15.1.7 [Error Thresholding].                                                                                                                                                                                                                                                                                                                                                                                                                                                              |      |             |       |                    |       |                                                                |     |                                                                                                                                                          |     |          |
| 50:49 | <b>IntType: interrupt type.</b> IF (D18F3x44[NbMcaToMstCpuEn] && !NBC) THEN RAZ; <b>Per-node</b> ; not-same-for-all. ELSIF (MSRC001_0015[McStatusWrEn]   ~MSR0000_0413[Locked]) THEN Read-write; <b>Per-node</b> ; not-same-for-all. ELSE Read-only; <b>Per-node</b> ; not-same-for-all. Cold reset: 0. ENDIF. Specifies the type of interrupt signaled when Ovrflw is set.<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>No Interrupt.</td></tr> <tr> <td>01b</td><td>APIC. APIC based interrupt (see LvtOffset above) to all cores.</td></tr> <tr> <td>10b</td><td>SMI. SMI trigger event (always routed to CpuCoreNum 0, as defined in 2.4.4 [Processor Cores and Downcoring]); see 2.4.10.2.3 [SMI Sources And Delivery].</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table> | Bits | Description | 00b   | No Interrupt.      | 01b   | APIC. APIC based interrupt (see LvtOffset above) to all cores. | 10b | SMI. SMI trigger event (always routed to CpuCoreNum 0, as defined in 2.4.4 [Processor Cores and Downcoring]); see 2.4.10.2.3 [SMI Sources And Delivery]. | 11b | Reserved |
| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |      |             |       |                    |       |                                                                |     |                                                                                                                                                          |     |          |
| 00b   | No Interrupt.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |      |             |       |                    |       |                                                                |     |                                                                                                                                                          |     |          |
| 01b   | APIC. APIC based interrupt (see LvtOffset above) to all cores.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |      |             |       |                    |       |                                                                |     |                                                                                                                                                          |     |          |
| 10b   | SMI. SMI trigger event (always routed to CpuCoreNum 0, as defined in 2.4.4 [Processor Cores and Downcoring]); see 2.4.10.2.3 [SMI Sources And Delivery].                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |      |             |       |                    |       |                                                                |     |                                                                                                                                                          |     |          |
| 11b   | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |      |             |       |                    |       |                                                                |     |                                                                                                                                                          |     |          |
| 48    | <b>Ovrflw: overflow.</b> IF (D18F3x44[NbMcaToMstCpuEn] && !NBC) THEN RAZ; <b>Per-node</b> ; not-same-for-all. ELSIF (MSRC001_0015[McStatusWrEn]   ~Locked) THEN Read-write; <b>Per-node</b> ; not-same-for-all; set-by-hardware. ELSE Read-only; <b>Per-node</b> ; not-same-for-all; set-by-hardware. Cold reset: 0. ENDIF. Set by hardware when ErrCnt transitions from FFEh to FFFh. When this bit is set, the interrupt selected by the IntType field is generated.                                                                                                                                                                                                                                                                                                                                                 |      |             |       |                    |       |                                                                |     |                                                                                                                                                          |     |          |
| 47:44 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |      |             |       |                    |       |                                                                |     |                                                                                                                                                          |     |          |



|       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 43:32 | <b>ErrCnt: error counter.</b> IF (D18F3x44[NbMcaToMstCpuEn] && !NBC) THEN RAZ; <b>Per-node</b> ; not-same-for-all. ELSIF (MSRC001_0015[McStatusWrEn]   ~Locked) THEN Read-write; <b>Per-node</b> ; not-same-for-all; updated-by-hardware. ELSE Read-only; <b>Per-node</b> ; not-same-for-all; updated-by-hardware. Cold reset: 0. ENDIF. Written by software to set the starting value of the error counter. Incremented by hardware when errors are logged. Saturates at FFFh (no rollover). The threshold value, written by software, is (FFFh - the desired error count (the number of errors necessary in order for an interrupt to be taken)). |
| 31:24 | <b>BlkPtr: Block pointer for additional MISC registers.</b> Read-only. Value: 01h. 01h=Extended MC4_MISC MSR block is valid.<br>See <a href="#">MSRC000_0408</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 23:0  | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |

### MSR0000\_0414 MC5 Machine Check Control (MC5\_CTL)

Read-write. Reset: 0000\_0000\_0000\_0000h. See 2.15.1 [Machine Check Architecture]. See [MSRC001\\_0049](#) [EX Machine Check Control Mask (MC5\_CTL\_MASK)].

| Bits  | Description                                                                                         |
|-------|-----------------------------------------------------------------------------------------------------|
| 63:16 | Unused.                                                                                             |
| 15    | Unused.                                                                                             |
| 14    | Unused.                                                                                             |
| 13    | <b>STATQ: retire status queue parity.</b>                                                           |
| 12    | <b>DE: DE error.</b>                                                                                |
| 11    | <b>FRF: flag register file parity.</b>                                                              |
| 10    | <b>AG1PRF: physical register file AG1 port parity.</b>                                              |
| 9     | <b>AG0PRF: physical register file AG0 port parity.</b>                                              |
| 8     | <b>EX1PRF: physical register file EX1 port parity.</b>                                              |
| 7     | <b>EX0PRF: physical register file EX0 port parity.</b>                                              |
| 6     | <b>MAP: mapper checkpoint array parity.</b>                                                         |
| 5     | <b>RETDISP: retire dispatch queue parity.</b>                                                       |
| 4     | <b>IDF: IDR array parity.</b>                                                                       |
| 3     | <b>PLDEX: EX payload array parity.</b>                                                              |
| 2     | <b>PLDAG: AG payload array parity.</b>                                                              |
| 1     | Reserved.                                                                                           |
| 0     | <b>WDT: core watchdog timer.</b> See <a href="#">MSRC001_0074</a> [CPU Watchdog Timer (CpuWdtCfg)]. |

### MSR0000\_0415 MC5 Machine Check Status (MC5\_STATUS)

Cold reset: 0000\_0000\_0000\_0000h. See 2.15.1 [Machine Check Architecture]. See [MSRC001\\_0015](#)[McStatusWrEn]. [Table 239](#) describes each error type. [Table 240](#) describes the error codes and status register settings for each error type.



| Bits  | Description                                                                                                                                                                                |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 63    | <b>Val: error valid.</b> See: <a href="#">MSR0000_0401[Val]</a> .                                                                                                                          |
| 62    | <b>Overflow: error overflow.</b> See: <a href="#">MSR0000_0401[Overflow]</a> .                                                                                                             |
| 61    | <b>UC: error uncorrected.</b> See: <a href="#">MSR0000_0401[UC]</a> .                                                                                                                      |
| 60    | <b>En: error enable.</b> See: <a href="#">MSR0000_0401[En]</a> .                                                                                                                           |
| 59    | <b>MiscV: miscellaneous error register valid.</b><br>Read-write; Updated-by-hardware.<br>See: <a href="#">MSR0000_0401[MiscV]</a> . 1=Valid thresholding in <a href="#">MSR0000_0417</a> . |
| 58    | <b>AddrV: error address valid.</b> See: <a href="#">MSR0000_0401[AddrV]</a> . 1=Valid address in <a href="#">MSR0000_0416</a> .                                                            |
| 57    | <b>PCC: processor context corrupt.</b> See: <a href="#">MSR0000_0401[PCC]</a> .                                                                                                            |
| 56:24 | Reserved.                                                                                                                                                                                  |
| 23:21 | Reserved.                                                                                                                                                                                  |
| 20:16 | <b>ErrorCodeExt: extended error code.</b> Read-write; Updated-by-hardware. See <a href="#">MSR0000_0401[ErrorCodeExt]</a> . See <a href="#">Table 240</a> for values.                      |
| 15:0  | <b>ErrorCode: error code.</b> Read-write; Updated-by-hardware. See <a href="#">2.15.1.5 [Error Code]</a> See <a href="#">Table 240</a> .                                                   |

**Table 239: MC5 Error Descriptions**

| Error Type | Error Sub-type                  | Description                                                                                    | CTL <sup>1</sup> | EAC <sup>3</sup> |
|------------|---------------------------------|------------------------------------------------------------------------------------------------|------------------|------------------|
| WDT error  | -                               | The WDT timer has expired. See <a href="#">MSRC001_0074 [CPU Watchdog Timer (CpuWdtCfg)]</a> . | WDT              | E                |
| Internal   | Wakeup array<br>dest tag parity | A parity error occurred in the wakeup array.                                                   | PICWA<br>K       | D                |

**Table 239: MC5 Error Descriptions**

| Error Type | Error Sub-type                 | Description                                                                                                                                                                                    | CTL <sup>1</sup> | EAC <sup>3</sup> |
|------------|--------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|------------------|
| Internal   | AG payload array parity        | A parity error occurred in the address generator payload array.                                                                                                                                | PLDAG            | D                |
|            | EX payload array parity        | A parity error occurred in the EX payload array.                                                                                                                                               | PLDEX            | D                |
|            | IDRF array parity              | A parity error occurred in the immediate displacement register file.                                                                                                                           | IDF              | D                |
|            | Retire dispatch queue parity   | A parity error occurred in the retire dispatch queue. This error causes the processor to enter the Shutdown state; <a href="#">2.15.1.3.1 [MCA conditions that cause Shutdown]</a> .           | RETDISP          | E                |
|            | Mapper checkpoint array parity | A parity error occurred in the mapper checkpoint array. This error causes the processor to enter the Shutdown state if UC=1; <a href="#">2.15.1.3.1 [MCA conditions that cause Shutdown]</a> . | MAP              | D                |
|            | EX0PRF parity                  | A parity error occurred in the physical register file's EX0 port.                                                                                                                              | EX0PRF           | D                |
|            | EX1PRF parity                  | A parity error occurred in the physical register file's EX1 port.                                                                                                                              | EX1PRF           | D                |
|            | AG0PRF parity                  | A parity error occurred in the physical register file's AG0 port.                                                                                                                              | AG0PRF           | D                |
|            | AG1PRF parity                  | A parity error occurred in the physical register file's AG1 port.                                                                                                                              | AG1PRF           | D                |
|            | Flag register file parity      | A parity error occurred in the flag register file.                                                                                                                                             | FRF              | D                |
|            | DE error                       | A DE error occurred.                                                                                                                                                                           | DE               | E                |
| Internal   | Retire status queue parity     | A parity error occurred in the retire status queue. This error causes the processor to enter the Shutdown state; <a href="#">2.15.1.3.1 [MCA conditions that cause Shutdown]</a>               | STATQ            | D                |

1. CTL: See [MSR0000\\_0414](#).

2. CID: core ID. All EX errors are reported to the affected core; see [2.15.1.3 \[Error Detection, Action, Logging, and Reporting\]](#).

3. EAC: D=Error action taken if detected. E=Error action taken if MCA bank enabled. See [2.15.1.3 \[Error Detection, Action, Logging, and Reporting\]](#).

**Table 240: MC5 Error Signatures**

| Error Type     | Error Sub-Type               | Error Code Ext | Error Code |       |    |      |       |    | UC  | ADDRV | MISCV | PCC | CECC | UECC |
|----------------|------------------------------|----------------|------------|-------|----|------|-------|----|-----|-------|-------|-----|------|------|
|                |                              |                | Type       | UU/PP | TT | RRRR | II/TT | LL |     |       |       |     |      |      |
| WDT error      | -                            | 00h            | BUS        | GEN   | 1  | GEN  | GEN   | LG | 1   | 1     | 1     | 1   | 0    | 0    |
| Internal error | Wakeup array dest tag parity | 01h            | BUS        | GEN   | 0  | GEN  | GEN   | LG | 1/0 | 0     | 0     | 0   | 0    | 0    |

**Table 240: MC5 Error Signatures**

| Error Type     | Error Sub-Type                 | ErrorC<br>odeExt | Error Code |           |    |      |       |    | UC               | ADDRV | MISCV | PCC              | CECC | UECC |
|----------------|--------------------------------|------------------|------------|-----------|----|------|-------|----|------------------|-------|-------|------------------|------|------|
|                |                                |                  | Type       | UU/P<br>P | TT | RRRR | II/TT | LL |                  |       |       |                  |      |      |
| Internal error | AG payload array parity        | 02h              | BUS        | GEN       | 0  | GEN  | GEN   | LG | 1/0              | 1     | 0     | 0                | 0    | 0    |
|                | EX payload array parity        | 03h              |            |           |    |      |       |    | 1/0              | 1     | 0     | 0                | 0    | 0    |
|                | IDRF array parity              | 04h              |            |           |    |      |       |    | 1/0              | 1     | 0     | 0                | 0    | 0    |
|                | Retire dispatch queue parity   | 05h              |            |           |    |      |       |    | 1 <sup>1</sup>   | 1     | 0     | 0                | 0    | 0    |
|                | Mapper checkpoint array parity | 06h              |            |           |    |      |       |    | 1/0 <sub>2</sub> | 1     | 0     | 0                | 0    | 0    |
|                | EX0PRF parity                  | 07h              |            |           |    |      |       |    | 1/0              | 0     | 0     | 0                | 0    | 0    |
|                | EX1PRF parity                  | 08h              |            |           |    |      |       |    | 1/0              | 0     | 0     | 0                | 0    | 0    |
|                | AG0PRF parity                  | 09h              |            |           |    |      |       |    | 1/0              | 0     | 0     | 0                | 0    | 0    |
|                | AG1PRF parity                  | 0Ah              |            |           |    |      |       |    | 1/0              | 0     | 0     | 0                | 0    | 0    |
|                | Flag register file parity      | 0Bh              |            |           |    |      |       |    | 1/0              | 0     | 0     | 0                | 0    | 0    |
|                | DE error                       | 0Ch              |            |           |    |      |       |    | 1/0 <sub>2</sub> | 0     | 0     | 0                | 0    | 0    |
| Internal error | Retire status queue parity     | 0Dh              | BUS        | GEN       | 0  | GEN  | GEN   | LG | 1 <sup>1</sup>   | 1     | 0     | 1/0 <sup>3</sup> | 0    | 0    |

1. Causes shutdown.  
2. Causes shutdown if UC=1.  
3. STATQ sets PCC=1 if a store retired in last 3 cycles or FpTokenRet bits mismatch.

**MSR0000\_0416 MC5 Machine Check Address (MC5\_ADDR)**

Read-write; Updated-by-hardware. Cold reset: 0000\_0000\_0000\_0000h. The MCi\_ADDR register contains valid data if indicated by MCi\_STATUS[AddrV]. See 2.15.1 [Machine Check Architecture]. The register format depends on the type of error being logged.

| Bits | Description                 |
|------|-----------------------------|
| 63:0 | <b>ADDR.</b> See Table 241. |

The following tables define the address register as a function of error type.

**Table 241: MC5 Address Register**

| Error Type | Error Sub-Type       | Bits  | Description                                                                                       |
|------------|----------------------|-------|---------------------------------------------------------------------------------------------------|
| WDT        | - (ErrorCodeExt=00h) | 63:48 | Reserved                                                                                          |
|            |                      | 47:0  | <b>LogAddr[47:0].</b> Logical address of the next instruction after the last instruction retired. |

**Table 241: MC5 Address Register**

| Error Type | Error Sub-Type                                                                                                               | Bits | Description          |
|------------|------------------------------------------------------------------------------------------------------------------------------|------|----------------------|
| Internal   | AG payload array parity (ErrorCodeExt=02h), EX payload array parity (ErrorCodeExt=03h), IDRF array parity (ErrorCodeExt=04h) | 63:6 | Reserved             |
|            |                                                                                                                              | 5:0  | <b>SchedulerQID.</b> |
| Internal   | Retire dispatch queue parity (ErrorCodeExt=05h)                                                                              | 63:7 | Reserved             |
|            |                                                                                                                              | 6:0  | <b>RetirementID.</b> |
| Internal   | STATQ parity (ErrorCodeExt=0Dh)                                                                                              | 63:7 | Reserved             |
|            |                                                                                                                              | 6:0  | <b>RetirementID.</b> |
| Internal   | Mapper checkpoint array parity (ErrorCodeExt=06h)                                                                            | 63:6 | Reserved             |
|            |                                                                                                                              | 5:0  | <b>CheckpointID.</b> |

**MSR0000\_0417 MC5 Machine Check Miscellaneous (MC5\_MISC)**

Cold reset: 0000\_0000\_0000\_0000h. This register records unspecified, implementation-specific status bits when an FR machine check error is logged.

See [2.15.1.7 \[Error Thresholding\]](#).

| Bits  | Description                                                                                             |
|-------|---------------------------------------------------------------------------------------------------------|
| 63    | <b>Valid.</b> See: <a href="#">MSR0000_0403[Valid]</a> .                                                |
| 62    | <b>CntP: counter present.</b> See: <a href="#">MSR0000_0403[CntP]</a> .                                 |
| 61    | <b>Locked.</b> See: <a href="#">MSR0000_0403[Locked]</a> .                                              |
| 60    | <b>IntP: Interrupt support present.</b> See: <a href="#">MSR0000_0403[IntP]</a> .                       |
| 59:56 | Reserved.                                                                                               |
| 55:52 | <b>LvtOffset: LVT offset.</b> See: <a href="#">MSR0000_0403[LvtOffset]</a> .                            |
| 51    | <b>CntEn: counter enable.</b> See: <a href="#">MSR0000_0403[CntEn]</a> .                                |
| 50:49 | <b>IntType: interrupt type.</b> See: <a href="#">MSR0000_0403[IntType]</a> .                            |
| 48    | <b>Ovrflw: overflow.</b> See: <a href="#">MSR0000_0403[Ovrflw]</a> .                                    |
| 47:44 | Reserved.                                                                                               |
| 43:32 | <b>ErrCnt: error counter.</b> See: <a href="#">MSR0000_0403[ErrCnt]</a> .                               |
| 31:24 | <b>BlkPtr: Block pointer for additional MISC registers.</b> See: <a href="#">MSR0000_0403[BlkPtr]</a> . |
| 23:0  | Reserved.                                                                                               |

**MSR0000\_0418 MC6 Machine Check Control (MC6\_CTL)**

**Per-compute-unit;** Read-write. Reset: 0000\_0000\_0000\_0000h. See [2.15.1 \[Machine Check Architecture\]](#). See [MSRC001\\_004A \[FP Machine Check Control Mask \(MC6\\_CTL\\_MASK\)\]](#).

| Bits | Description |
|------|-------------|
| 63:7 | Unused.     |

|   |                                                  |
|---|--------------------------------------------------|
| 6 | Unused.                                          |
| 5 | <b>SRF: status register file parity error.</b>   |
| 4 | <b>RetireQ: retire queue parity error.</b>       |
| 3 | Unused.                                          |
| 2 | <b>Sched: scheduler table parity error.</b>      |
| 1 | <b>FreeList: free list parity error.</b>         |
| 0 | <b>PRF: physical register file parity error.</b> |

### MSR0000\_0419 MC6 Machine Check Status (MC6\_STATUS)

See 2.15.1 [Machine Check Architecture]. See MSRC001\_0015[McStatusWrEn]. Table 242 describes each error type. Table 243 describes the error codes and status register settings for each error type.

| Bits  | Description                                                                                                                                                                                                                                                                                                              |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 63    | <b>Val: valid.</b> See: MSR0000_0401[Val].                                                                                                                                                                                                                                                                               |
| 62    | <b>Overflow: error overflow.</b> See: MSR0000_0401[Overflow].                                                                                                                                                                                                                                                            |
| 61    | <b>UC: error uncorrected.</b> See: MSR0000_0401[UC].                                                                                                                                                                                                                                                                     |
| 60    | <b>En: error enable.</b> See: MSR0000_0401[En].                                                                                                                                                                                                                                                                          |
| 59    | <b>MiscV: miscellaneous error register valid.</b> Read-only. Value: 0. See: MSR0000_0401[MiscV].                                                                                                                                                                                                                         |
| 58    | <b>AddrV: error address valid.</b> Read-only. Value: 0. See: MSR0000_0401[AddrV].                                                                                                                                                                                                                                        |
| 57    | <b>PCC: processor context corrupt.</b> See: MSR0000_0401[PCC].                                                                                                                                                                                                                                                           |
| 56:21 | Reserved.                                                                                                                                                                                                                                                                                                                |
| 20:16 | <b>ErrorCodeExt: extended error code.</b> Read-write; Updated-by-hardware. Logs an extended error code when an error is detected. This model-specific field is used in conjunction with ErrorCode to identify the error sub-type for root cause analysis (see 2.15.1.5 [Error Code]). See Table 243 for expected values. |
| 15:0  | <b>ErrorCode: error code.</b> Read-write; Updated-by-hardware. See 2.15.1.5 [Error Code] for details on decoding this field. See Table 243 for expected values.                                                                                                                                                          |

**Table 242: MC6 Error Descriptions**

| Error Type          | Error                  | Description <sup>2</sup>                                     | CTL <sup>4</sup> | CID <sup>3</sup> | EAC <sup>1</sup> |
|---------------------|------------------------|--------------------------------------------------------------|------------------|------------------|------------------|
| Floating Point Unit | Physical Register File | A parity error occurred in the Physical Register File (PRF). | PRF              | 0                | E                |
|                     | Status Register File   | A parity error occurred in the Status Register File (SRF).   | SRF              | A                | E                |
|                     | Free List              | A parity error occurred on the Free List.                    | FreeList         | 0                | E                |
|                     | Retire Queue           | A parity error occurred in the Retire Queue.                 | RetireQ          | 0                | E                |
|                     | Scheduler              | A parity error occurred in the Scheduler table.              | Sched            | 0                | E                |

**Table 242: MC6 Error Descriptions**

| Error Type                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Error | Description <sup>2</sup> | CTL <sup>4</sup> | CID <sup>3</sup> | EAC <sup>1</sup> |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|--------------------------|------------------|------------------|------------------|
| 1. EAC: D=Error action taken if detected. E=Error action taken if MCA bank enabled.<br>See <a href="#">2.15.1.3 [Error Detection, Action, Logging, and Reporting]</a> .<br>2. All FP errors are system fatal and result in a sync flood.<br>3. CID: core ID. A=Error reported to the affected core. 0=Error reported to core 0 of the compute unit;<br>see <a href="#">2.15.1.3 [Error Detection, Action, Logging, and Reporting]</a> .<br>4. See <a href="#">MSR0000_0418</a> . |       |                          |                  |                  |                  |

**Table 243: MC6 Error Signatures**

| Error Type          | Error Sub-Type         | ErrorC<br>odeExt | Error Code |           |   |      |     |    | UC | ADDRV | PCC |
|---------------------|------------------------|------------------|------------|-----------|---|------|-----|----|----|-------|-----|
|                     |                        |                  | Type       | UU/<br>PP | T | RRRR | II  | LL |    |       |     |
| Floating Point Unit | Status Register File   | 00101b           | BUS        | GEN       | 0 | GEN  | GEN | LG | 1  | 0     | 1   |
|                     | Physical Register File | 00010b           |            |           |   |      |     |    |    |       |     |
|                     | Free List              | 00001b           |            |           |   |      |     |    |    |       |     |
|                     | Retire Queue           | 00011b           |            |           |   |      |     |    |    |       |     |
|                     | Scheduler              | 00100b           |            |           |   |      |     |    |    |       |     |

**MSR0000\_041A MC6 Machine Check Address (MC6\_ADDR)**

Reset: 0000\_0000\_0000\_0000h. Read-only. See [2.15.1 \[Machine Check Architecture\]](#).

| Bits | Description |
|------|-------------|
| 63:0 | Reserved.   |

**MSR0000\_041B MC6 Machine Check Miscellaneous (MC6\_MISC)**

Reset: 0000\_0000\_0000\_0000h. Read-only. See [2.15.1 \[Machine Check Architecture\]](#).

| Bits | Description |
|------|-------------|
| 63:0 | Reserved.   |

### 3.20 MSRs - MSRC000\_0xxx

#### MSRC000\_0080 Extended Feature Enable (EFER)

SKINIT Execution: 0000\_0000\_0000\_0000h.

| Bits  | Description                                                                                                                                                                                                                                                                                                                     |
|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 63:16 | MBZ.                                                                                                                                                                                                                                                                                                                            |
| 15    | <b>TCE: translation cache extension enable.</b> Read-write. Reset: 0. 1=Translation cache extension is enabled.                                                                                                                                                                                                                 |
| 14    | <b>FFXSE: fast FXSAVE/FRSTOR enable.</b> Read-write. Reset: 0. 1=Enables the fast FXSAVE/FRSTOR mechanism. A 64-bit operating system may enable the fast FXSAVE/FRSTOR mechanism if ( <a href="#">CPUID Fn8000_0001_EDX</a> [FFXSR]==1)). This bit is set once by the operating system and its value is not changed afterwards. |
| 13    | <b>LMSLE: long mode segment limit enable.</b> Read-write. Reset: 0. 1=Enables the long mode segment limit check mechanism.                                                                                                                                                                                                      |
| 12    | <b>SVME: secure virtual machine (SVM) enable.</b> IF ( <a href="#">MSRC001_0114</a> [SvmeDisable]==1) THEN MBZ. ELSE Read-write. ENDIF. Reset: 0. 1=SVM features are enabled.                                                                                                                                                   |
| 11    | <b>NXE: no-execute page enable.</b> Read-write. Reset: 0. 1=The no-execute page protection feature is enabled.                                                                                                                                                                                                                  |
| 10    | <b>LMA: long mode active.</b> Read-only. Reset: 0. 1=Indicates that long mode is active.                                                                                                                                                                                                                                        |
| 9     | MBZ.                                                                                                                                                                                                                                                                                                                            |
| 8     | <b>LME: long mode enable.</b> Read-write. Reset: 0. 1=Long mode is enabled.                                                                                                                                                                                                                                                     |
| 7:1   | RAZ.                                                                                                                                                                                                                                                                                                                            |
| 0     | <b>SYSCALL: system call extension enable.</b> Read-write. Reset: 0. 1=SYSCALL and SYSRET instructions are enabled. This adds the SYSCALL and SYSRET instructions which can be used in flat addressed operating systems as low latency system calls and returns.                                                                 |

#### MSRC000\_0081 SYSCALL Target Address (STAR)

Reset: 0000\_0000\_0000\_0000h. This register holds the target address used by the SYSCALL instruction and the code and stack segment selector bases used by the SYSCALL and SYSRET instructions.

| Bits  | Description                                        |
|-------|----------------------------------------------------|
| 63:48 | <b>SysRetSel: SYSRET CS and SS.</b> Read-write.    |
| 47:32 | <b>SysCallSel: SYSCALL CS and SS.</b> Read-write.  |
| 31:0  | <b>Target: SYSCALL target address.</b> Read-write. |

#### MSRC000\_0082 Long Mode SYSCALL Target Address (STAR64)

Reset: 0000\_0000\_0000\_0000h.

| Bits | Description                                                                                                                                                                                                |
|------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 63:0 | <b>LSTAR: long mode target address.</b> Read-write. Target address for 64-bit mode calling programs. The address stored in this register must be in canonical form (if not canonical, a #GP fault occurs). |

**MSRC000\_0083 Compatibility Mode SYSCALL Target Address (STARCOMPAT)**

Reset: 0000\_0000\_0000\_0000h.

| Bits | Description                                                                                                                                                                                               |
|------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 63:0 | <b>CSTAR: compatibility mode target address.</b> Read-write. Target address for compatibility mode. The address stored in this register must be in canonical form (if not canonical, a #GP fault occurs). |

**MSRC000\_0084 SYSCALL Flag Mask (SYSCALL\_FLAG\_MASK)**

| Bits  | Description                                                                                                                                                                                                      |
|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 63:32 | RAZ.                                                                                                                                                                                                             |
| 31:0  | <b>Mask: SYSCALL flag mask.</b> Read-write. Reset: 0000_0000h. This register holds the EFLAGS mask used by the SYSCALL instruction. 1=Clear the corresponding EFLAGS bit when executing the SYSCALL instruction. |

**MSRC000\_00E7 Read-Only Max Performance Frequency Clock Count (MPerfReadOnly)**

Reset: 0000\_0000\_0000\_0000h.

| Bits | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 63:0 | <b>MPerfReadOnly: read-only maximum core clocks counter.</b> IF ( <a href="#">MSRC001_0015</a> [EffFreqReadOnlyLock]) THEN Read-only; Updated-by-hardware. ELSE Read-write; Updated-by-hardware. ENDIF. Incremented by hardware at the P0 frequency while the core is in C0. This register does not increment when the core is in the stop-grant state. In combination with <a href="#">MSRC000_00E8</a> , this is used to determine the effective frequency of the core. A read of this MSR in guest mode is affected by <a href="#">MSRC000_0104</a> [Time Stamp Counter Ratio (TscRateMsr)]. This field uses software P-state numbering. See <a href="#">MSRC001_0015</a> [EffFreqCntMwait], <a href="#">2.5.3.3</a> [Effective Frequency], and <a href="#">2.5.3.1.1.1</a> [Software P-state Numbering]. This register is not affected by writes to <a href="#">MSR0000_00E7</a> . |

**MSRC000\_00E8 Read-Only Actual Performance Frequency Clock Count (APerfReadOnly)**

Reset: 0000\_0000\_0000\_0000h.

| Bits | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 63:0 | <b>APerfReadOnly: read-only actual core clocks counter.</b> IF ( <a href="#">MSRC001_0015</a> [EffFreqReadOnlyLock]) THEN Read-only; Updated-by-hardware. ELSE Read-write; Updated-by-hardware. ENDIF. This register increments in proportion to the actual number of core clocks cycles while the core is in C0. The register does not increment when the core is in the stop-grant state. See <a href="#">MSRC000_00E7</a> . This register is not affected by writes to <a href="#">MSR0000_00E8</a> . |

**MSRC000\_0100 FS Base (FS\_BASE)**

Reset: 0000\_0000\_0000\_0000h.



| Bits | Description                                                                                                                                                                                                                                             |
|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 63:0 | <b>FSBase: expanded FS segment base.</b> Read-write; not-same-for-all. This register provides access to the expanded 64-bit FS segment base. The address stored in this register must be in canonical form (if not canonical, a #GP fault fill occurs). |

#### MSRC000\_0101 GS Base (GS\_BASE)

Reset: 0000\_0000\_0000\_0000h.

| Bits | Description                                                                                                                                                                                                                                             |
|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 63:0 | <b>GSBase: expanded GS segment base.</b> Read-write; not-same-for-all. This register provides access to the expanded 64-bit GS segment base. The address stored in this register must be in canonical form (if not canonical, a #GP fault fill occurs). |

#### MSRC000\_0102 Kernel GS Base (KernelGSbase)

Reset: 0000\_0000\_0000\_0000h.

| Bits | Description                                                                                                                                                                                                                                                                                              |
|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 63:0 | <b>KernelGSBase: kernel data structure pointer.</b> Read-write. This register holds the kernel data structure pointer which can be swapped with the GS_BASE register using the SwapGS instruction. The address stored in this register must be in canonical form (if not canonical, a #GP fault occurs). |

#### MSRC000\_0103 Auxiliary Time Stamp Counter (TSC\_AUX)

Reset: 0000\_0000\_0000\_0000h.

| Bits  | Description                                                                                                                                                                                                                   |
|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 63:32 | Reserved.                                                                                                                                                                                                                     |
| 31:0  | <b>TscAux: auxiliary time stamp counter data.</b> Read-write. It is expected that this is initialized by privileged software to a meaningful value, such as a processor ID. This value is returned in the RDTSCP instruction. |

#### MSRC000\_0104 Time Stamp Counter Ratio (TscRateMsr)

[MSRC000\\_0104 \[Time Stamp Counter Ratio \(TscRateMsr\)\]](#) allows the hypervisor to control the guest's view of the Time Stamp Counter. It provides a multiplier that scales the value returned when [MSR0000\\_0010\[TSC\]](#), [MSR0000\\_00E7\[MPERF\]](#), and [MSRC000\\_00E7\[MPerfReadOnly\]](#) are read by a guest running under virtualization. This allows the hypervisor to provide a consistent TSC, MPERF, and MPerfReadOnly rate for a guest process when moving that process between cores that have a differing P0 rate. The TSC Ratio MSR does not affect the value read from the TSC, MPERF, and MPerfReadOnly MSRs when read when in host mode or when virtualization is not being used or when accessed by code executed in system management mode (SMM) unless the SMM code is executed within a guest container. The TSC Ratio value does not affect the rate of the underlying TSC, MPERF, and MPerfReadOnly counters, or the value that gets written to the TSC, MPERF, and MPerfReadOnly MSRs counters on a write by either the host or the guest. The TSC Ratio MSR contains a fixed-point number in 8.32 format, which is 8 bits of integer and 32 bits of fraction. This number is the ratio of the desired P0 frequency to the P0 frequency of the core. The reset value of the TSC Ratio MSR is 1.0, which results in a guest frequency matches the core P0 frequency.

| Bits  | Description                                                                                                                                       |
|-------|---------------------------------------------------------------------------------------------------------------------------------------------------|
| 63:40 | MBZ.                                                                                                                                              |
| 39:32 | <b>TscRateMsrInt: time stamp counter rate integer.</b> Read-write. Reset: 01h. Specifies the integer part of the MSR TSC ratio value.             |
| 31:0  | <b>TscRateMsrFrac: time stamp counter rate fraction.</b> Read-write. Reset: 0000_0000h. Specifies the fractional part of the MSR TSC ratio value. |

### MSRC000\_0105 Lightweight Profile Configuration (LWP\_CFG)

| Bits  | Description                                                                                                                                                                                                                                               |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 63:48 | Reserved.                                                                                                                                                                                                                                                 |
| 47:40 | <b>LwpVector: threshold interrupt vector.</b> Read-write. Reset: 0. Interrupt vector number used by LWP Threshold interrupts. Must be provided if LwpInt is set to 1.                                                                                     |
| 39:32 | <b>LwpCoreId: core ID.</b> Read-write. Reset: 0. Core identification stored into the trace record. BIOS: <a href="#">CPUID Fn0000_0001_EBX[LocalApicId]</a> . Software is recommended to set this to <a href="#">CPUID Fn0000_0001_EBX[LocalApicId]</a> . |
| 31    | <b>LwpInt: interrupt on threshold overflow.</b> Read-write. Reset: 0. 1=Enable LWP to interrupt on threshold overflow. <a href="#">CPUID Fn8000_001C_EAX[LwpInt]</a> is an alias of <a href="#">MSRC000_0105[LwpInt]</a> .                                |
| 30    | <b>LwpPTSC: performance time stamp counter in event record.</b> Read-write. Reset: 0. 1=Enable storing performance time stamp in event record. <a href="#">CPUID Fn8000_001C_EAX[LwpPTSC]</a> is an alias of <a href="#">MSRC000_0105[LwpPTSC]</a> .      |
| 29    | <b>LwpCont: sampling in continuous mode.</b> Read-write. Reset: 0. 1=Enable continuous mode. 0=Enable synchronized mode. <a href="#">CPUID Fn8000_001C_EAX[LwpCont]</a> is an alias of <a href="#">MSRC000_0105[LwpCont]</a> .                            |
| 28:7  | MBZ.                                                                                                                                                                                                                                                      |
| 6     | <b>LwpRNH: core reference clocks not halted event support.</b> MBZ. Reset: 0. 1=Enable LWP to count core reference clocks not halted. <a href="#">CPUID Fn8000_001C_EAX[LwpRNH]</a> is an alias of <a href="#">MSRC000_0105[LwpRNH]</a> .                 |
| 5     | <b>LwpCNH: core clocks not halted event support.</b> MBZ. Reset: 0. 1=Enable LWP to count core clocks not halted. <a href="#">CPUID Fn8000_001C_EAX[LwpCNH]</a> is an alias of <a href="#">MSRC000_0105[LwpCNH]</a> .                                     |
| 4     | <b>LwpDME: DC miss event support.</b> MBZ. Reset: 0. 1=Enable LWP to count DC misses. <a href="#">CPUID Fn8000_001C_EAX[LwpDME]</a> is an alias of <a href="#">MSRC000_0105[LwpDME]</a> .                                                                 |
| 3     | <b>LwpBRE: branch retired event support.</b> Read-write. Reset: 0. 1=Enable LWP to count branches retired. <a href="#">CPUID Fn8000_001C_EAX[LwpBRE]</a> is an alias of <a href="#">MSRC000_0105[LwpBRE]</a> .                                            |
| 2     | <b>LwpIRE: instructions retired event support.</b> Read-write. Reset: 0. 1=Enable LWP to count instructions retired. <a href="#">CPUID Fn8000_001C_EAX[LwpIRE]</a> is an alias of <a href="#">MSRC000_0105[LwpIRE]</a> .                                  |
| 1     | <b>LwpVAL: LWPVAL instruction support.</b> Read-write. Reset: 0. 1=LWPVAL instruction is enabled. <a href="#">CPUID Fn8000_001C_EAX[LwpVAL]</a> is an alias of <a href="#">MSRC000_0105[LwpVAL]</a> .                                                     |
| 0     | Reserved.                                                                                                                                                                                                                                                 |

### MSRC000\_0106 Lightweight Profile Control Block Address (LWP\_CBADDR)

Access to the internal copy of the LWPCB logical line/64 B address. A read returns the current LWPCB address without performing any of the operations described for the SLWPCB instruction. A write to this regis-

ter with a non-zero value will cause a #GP fault. Use LLWPCB or XRSTOR to load an LWPCB address. Writing a zero to LWP\_CBADDR will immediately disable LWP, discarding any internal state. For instance, an operating system can write a zero to stop LWP when it terminates a thread. All references to the LWPCB implicitly use the DS segment register. Must be 64 B aligned.

| Bits | Description                                                                                                                |
|------|----------------------------------------------------------------------------------------------------------------------------|
| 63:6 | <b>LwpCbAddr[63:6]: control block logical address.</b> Read-write. Reset: 0. LwpCbAddr[63:0] = {LwpCbAddr[63:6], 000000b}. |
| 5:0  | RAZ.                                                                                                                       |

#### **MSRC000\_0408 NB Machine Check Misc 4 (Link Thresholding) 1 (MC4\_MISC1)**

Per-node. [MSRC000\\_0408](#) is associated with the link error type. See [2.15.1.7 \[Error Thresholding\]](#). Accessibility of this register by non-NBC cores is affected by [D18F3x44\[NbMcaToMstCpuEn\]](#).

| Bits | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 63   | <b>Valid.</b> IF (D18F3x44[NbMcaToMstCpuEn] && !NBC) THEN RAZ; <b>Per-node</b> ; not-same-for-all. ELSIF (MSRC001_0015[McStatusWrEn]) THEN Read-write; <b>Per-node</b> ; not-same-for-all. ELSE Read-only; <b>Per-node</b> ; not-same-for-all. Reset: 1. ENDIF. 1=The CntP field is present.                                                                                                                                                                                                                                                                                   |
| 62   | <b>CntP: counter present.</b> IF (D18F3x44[NbMcaToMstCpuEn] && !NBC) THEN RAZ; <b>Per-node</b> ; not-same-for-all. ELSIF (MSRC001_0015[McStatusWrEn]) THEN Read-write; <b>Per-node</b> ; not-same-for-all. ELSE Read-only; <b>Per-node</b> ; not-same-for-all. Reset: 1. ENDIF. 1=A valid threshold counter is present.                                                                                                                                                                                                                                                        |
| 61   | <b>Locked.</b> IF (D18F3x44[NbMcaToMstCpuEn] && !NBC) THEN RAZ; <b>Per-node</b> ; not-same-for-all. ELSIF (MSRC001_0015[McStatusWrEn]) THEN Read-write; <b>Per-node</b> ; not-same-for-all. ELSE Read-only; <b>Per-node</b> ; not-same-for-all. Reset: 0. ENDIF. BIOS: IF (IntType==10b) THEN 1. ELSE 0. ENDIF. 1=Writes to bits [55:32] of this register are ignored. Set by BIOS to indicate that this register is not available for OS use. When MSRC001_0015[McStatusWrEn] is set, MSR writes to this register update all bits, regardless of the state of the Locked bit. |

| 60:56 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |      |             |       |                    |       |                                                                |     |                                                                                                                                                         |     |          |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|-------|--------------------|-------|----------------------------------------------------------------|-----|---------------------------------------------------------------------------------------------------------------------------------------------------------|-----|----------|
| 55:52 | <p><b>LvtOffset: LVT offset.</b> IF (D18F3x44[NbMcaToMstCpuEn] &amp;&amp; !NBC) THEN RAZ; <b>Per-node</b>; not-same-for-all. ELSIF (MSRC001_0015[McStatusWrEn]   ~MSRC000_0408[Locked]) THEN Read-write; <b>Per-node</b>; not-same-for-all. ELSE Read-only; <b>Per-node</b>; not-same-for-all. Reset: 0h. ENDIF. Specifies the address of the LVT entry in the APIC registers as follows: LVT address = (LvtOffset shifted left 4 bits) + 500h (see APIC[530:500]).</p> <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>3h-0h</td><td>See APIC[530:500].</td></tr> <tr> <td>Fh-4h</td><td>Reserved</td></tr> </table>                                                                                                                                                                                             | Bits | Description | 3h-0h | See APIC[530:500]. | Fh-4h | Reserved                                                       |     |                                                                                                                                                         |     |          |
| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |      |             |       |                    |       |                                                                |     |                                                                                                                                                         |     |          |
| 3h-0h | See APIC[530:500].                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |      |             |       |                    |       |                                                                |     |                                                                                                                                                         |     |          |
| Fh-4h | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |      |             |       |                    |       |                                                                |     |                                                                                                                                                         |     |          |
| 51    | <p><b>CntEn: counter enable.</b> IF (D18F3x44[NbMcaToMstCpuEn] &amp;&amp; !NBC) THEN RAZ; <b>Per-node</b>; not-same-for-all. ELSIF (MSRC001_0015[McStatusWrEn]   ~Locked) THEN Read-write; <b>Per-node</b>; not-same-for-all. ELSE Read-only; <b>Per-node</b>; not-same-for-all. Reset: 0. ENDIF. 1=Count thresholding errors. See 2.15.1.7 [Error Thresholding].</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                          |      |             |       |                    |       |                                                                |     |                                                                                                                                                         |     |          |
| 50:49 | <p><b>IntType: interrupt type.</b> IF (D18F3x44[NbMcaToMstCpuEn] &amp;&amp; !NBC) THEN RAZ; <b>Per-node</b>; not-same-for-all. ELSIF (MSRC001_0015[McStatusWrEn]   ~MSRC000_0408[Locked]) THEN Read-write; <b>Per-node</b>; not-same-for-all. ELSE Read-only; <b>Per-node</b>; not-same-for-all. Cold reset: 0. ENDIF. Specifies the type of interrupt signaled when Ovrflw is set.</p> <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>No Interrupt.</td></tr> <tr> <td>01b</td><td>APIC. APIC based interrupt (see LvtOffset above) to all cores.</td></tr> <tr> <td>10b</td><td>SMI. SMI trigger event (always routed to CpuCoreNum 0, as defined in 2.4.4 [Processor Cores and Downcoring]); see 2.4.9.2.3 [SMI Sources And Delivery].</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table> | Bits | Description | 00b   | No Interrupt.      | 01b   | APIC. APIC based interrupt (see LvtOffset above) to all cores. | 10b | SMI. SMI trigger event (always routed to CpuCoreNum 0, as defined in 2.4.4 [Processor Cores and Downcoring]); see 2.4.9.2.3 [SMI Sources And Delivery]. | 11b | Reserved |
| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |      |             |       |                    |       |                                                                |     |                                                                                                                                                         |     |          |
| 00b   | No Interrupt.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |      |             |       |                    |       |                                                                |     |                                                                                                                                                         |     |          |
| 01b   | APIC. APIC based interrupt (see LvtOffset above) to all cores.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |      |             |       |                    |       |                                                                |     |                                                                                                                                                         |     |          |
| 10b   | SMI. SMI trigger event (always routed to CpuCoreNum 0, as defined in 2.4.4 [Processor Cores and Downcoring]); see 2.4.9.2.3 [SMI Sources And Delivery].                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |      |             |       |                    |       |                                                                |     |                                                                                                                                                         |     |          |
| 11b   | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |      |             |       |                    |       |                                                                |     |                                                                                                                                                         |     |          |
| 48    | <p><b>Ovrflw: overflow.</b> IF (D18F3x44[NbMcaToMstCpuEn] &amp;&amp; !NBC) THEN RAZ; <b>Per-node</b>; not-same-for-all. ELSIF (MSRC001_0015[McStatusWrEn]   ~Locked) THEN Read-write; <b>Per-node</b>; not-same-for-all; set-by-hardware. ELSE Read-only; <b>Per-node</b>; not-same-for-all; set-by-hardware. Cold reset: 0. ENDIF. Set by hardware when ErrCnt transitions from FFEh to FFFh. When this bit is set, the interrupt selected by the IntType field is generated.</p>                                                                                                                                                                                                                                                                                                                                             |      |             |       |                    |       |                                                                |     |                                                                                                                                                         |     |          |
| 47:44 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |      |             |       |                    |       |                                                                |     |                                                                                                                                                         |     |          |
| 43:32 | <p><b>ErrCnt: error counter.</b> IF (D18F3x44[NbMcaToMstCpuEn] &amp;&amp; !NBC) THEN RAZ; <b>Per-node</b>; not-same-for-all. ELSIF (MSRC001_0015[McStatusWrEn]   ~Locked) THEN Read-write; <b>Per-node</b>; not-same-for-all; updated-by-hardware. ELSE Read-only; <b>Per-node</b>; not-same-for-all; updated-by-hardware. Cold reset: 0. ENDIF. Written by software to set the starting value of the error counter. Incremented by hardware when errors are logged. Saturates at FFFh (no rollover). The threshold value, written by software, is (FFFh - the desired error count (the number of errors necessary in order for an interrupt to be taken)).</p>                                                                                                                                                                |      |             |       |                    |       |                                                                |     |                                                                                                                                                         |     |          |
| 31:0  | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |      |             |       |                    |       |                                                                |     |                                                                                                                                                         |     |          |

#### MSRC000\_0409 Reserved

| Bits | Description |
|------|-------------|
| 63:0 | Reserved.   |

**MSRC000\_040[F:A] Reserved**

---

| Bits | Description |
|------|-------------|
| 63:0 | RAZ.        |

### 3.21 MSRs - MSRC001\_0xxx

#### MSRC001\_00[03:00] Performance Event Select (PERF\_CTL[3:0])

Reset: 0000\_0000\_0000\_0000h. See 2.6.1 [Performance Monitor Counters].

The legacy alias of MSRC001\_020[6,4,2,0]. See MSRC001\_020[A,8,6,4,2,0].

Table 244: Register Mapping for MSRC001\_00[03:00]

| Register     | Function  |
|--------------|-----------|
| MSRC001_0000 | Counter 0 |
| MSRC001_0001 | Counter 1 |
| MSRC001_0002 | Counter 2 |
| MSRC001_0003 | Counter 3 |

| Bits | Description                                            |
|------|--------------------------------------------------------|
| 63:0 | MSRC001_00[03:00] is an alias of MSRC001_020[6,4,2,0]. |

#### MSRC001\_00[07:04] Performance Event Counter (PERF\_CTR[3:0])

The legacy alias of MSRC001\_020[7,5,3,1]. See MSRC001\_020[B,9,7,5,3,1].

Table 245: Register Mapping for MSRC001\_00[07:04]

| Register     | Function  |
|--------------|-----------|
| MSRC001_0004 | Counter 0 |
| MSRC001_0005 | Counter 1 |
| MSRC001_0006 | Counter 2 |
| MSRC001_0007 | Counter 3 |

| Bits | Description                                            |
|------|--------------------------------------------------------|
| 63:0 | MSRC001_00[07:04] is an alias of MSRC001_020[7,5,3,1]. |

#### MSRC001\_0010 System Configuration (SYS\_CFG)

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                              |
|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 63:23 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                |
| 22    | <b>Tom2ForceMemTypeWB: top of memory 2 memory type write back.</b> Read-write; <i>Per-compute-unit</i> . . Reset: 0. 1=The default memory type of memory between 4GB and TOM2 is write back instead of the memory type defined by MSR0000_02FF[MemType]. For this bit to have any effect, MSR0000_02FF[MtrrDefTypeEn] must be 1. MTRRs and PAT can be used to override this memory type. |
| 21    | <b>MtrrTom2En: MTRR top of memory 2 enable.</b> Read-write; <i>Per-compute-unit</i> . . Reset: 0. 0=MSRC001_001D [Top Of Memory 2 (TOM2)] is disabled. 1=This register is enabled. See D0F0x64_x19[TomEn].                                                                                                                                                                               |

|      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 20   | <b>MtrrVarDramEn: MTRR variable DRAM enable.</b> Read-write; <a href="#">Per-compute-unit</a> . . Reset: 0. BIOS: 1. 0= <a href="#">MSRC001_001A [Top Of Memory (TOP_MEM)]</a> and IORRs are disabled. 1=These registers are enabled.                                                                                                                                                                                                                              |
| 19   | <b>MtrrFixDramModEn: MTRR fixed RdDram and WrDram modification enable.</b> Read-write. Reset: 0. Controls access to <a href="#">MSR0000_02[6F:68,59:58,50][RdDram, WrDram]</a> . 0=Access type is MBZ; writing 00b does not change the hidden value of <a href="#">MSR0000_02[6F:68,59:58,50][RdDram, WrDram]</a> . 1=Access type is Read-write. BIOS: This bit should be set to 1 during BIOS initialization of the fixed MTRRs, then cleared to 0 for operation. |
| 18   | <b>MtrrFixDramEn: MTRR fixed RdDram and WrDram attributes enable.</b> Read-write; <a href="#">Per-compute-unit</a> . . Reset: 0. BIOS: 1. 1=Enables the RdDram and WrDram attributes in <a href="#">MSR0000_02[6F:68,59:58,50]</a> .                                                                                                                                                                                                                               |
| 17   | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 16   | <b>ChgToDirtyDis: change to dirty disable.</b> Read-write; <a href="#">Per-compute-unit</a> . Reset: 0. 1=Disables Change-to-Dirty command; The change-to-dirty condition is handled by evicting the line and then fetching it with a RdBlkM command.                                                                                                                                                                                                              |
| 15:0 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                          |

#### MSRC001\_0015 Hardware Configuration (HWCR)

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 63:32 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 31:30 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 29    | <b>CSEnable: connected standby enable.</b> Read-write. Reset: 0. 0=Connected standby feature is disabled. No Local APIC writes to NB PCI space or C6 save space will occur on C6 entry. No Local APIC restore from C6 save space will occur on C6 exit. No C6 state save skip will occur. 1=Connected standby feature is enabled. Local APIC writes to NB PCI Space and C6 save space can occur if <a href="#">MSR0000_001B[ApicEn]</a> is set. Local APIC restore from C6 save space on C6 exit can occur if <a href="#">MSR0000_001B[ApicEn]</a> . |
| 28    | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 27    | <b>EffFreqReadOnlyLock: read-only effective frequency counter lock.</b> Write-1-only. Reset: 0. BIOS: 1. 1= <a href="#">MSRC000_00E7</a> and <a href="#">MSRC000_00E8</a> are read-only.                                                                                                                                                                                                                                                                                                                                                             |
| 26    | <b>EffFreqCntMwait: effective frequency counting during mwait.</b> Read-write. Reset: 0. Specifies whether <a href="#">MSR0000_00E7 [Max Performance Frequency Clock Count (MPERF)]</a> and <a href="#">MSR0000_00E8 [Actual Performance Frequency Clock Count (APERF)]</a> increment while the core is in the monitor event pending state. 0=The registers do not increment. 1=The registers increment. See <a href="#">2.5.3.3 [Effective Frequency]</a> .                                                                                         |
| 25    | <b>CpbDis: core performance boost disable.</b> Read-write. Reset: 0. Specifies whether core performance boost is requested to be enabled or disabled. 0=CPB is requested to be enabled. 1=CPB is disabled. See <a href="#">2.5.9 [Application Power Management (APM)]</a> . If core performance boost is disabled while a core is in a boosted P-state, the core will automatically transition to the highest performance non-boosted P-state.                                                                                                       |
| 24    | <b>TscFreqSel: TSC frequency select.</b> Read-only. Reset: 1. 1=The TSC increments at the P0 frequency. This field uses software P-state numbering. See <a href="#">2.5.3.1.1.1 [Software P-state Numbering]</a> .                                                                                                                                                                                                                                                                                                                                   |



|       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 23    | <b>ForceRdWrSzPrb: force probes for RdSized and WrSized.</b> Read-write. Reset: 0. A read returns a 1 if this field is set on any core of the node.<br>1=Forces probes on read-sized and write-sized transactions, except those that are display refresh.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 22:21 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 20    | <b>IoCfgGpFault: IO-space configuration causes a GP fault.</b> Read-write. Reset: 0. 1=IO-space accesses to configuration space cause a GP fault. The fault is triggered if any part of the IO read/write address range is between CF8h and CFFh, inclusive. These faults only result from single IO instructions, not to string and REP IO instructions. This fault takes priority over the IO trap mechanism described by <a href="#">MSRC001_0054 [IO Trap Control (SMI_ON_IO_TRAP_CTL_STS)]</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 19    | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 18    | <b>McStatusWrEn: machine check status write enable.</b> Read-write. Reset: 0. McStatusWrEn can be used to debug machine check exception and interrupt handlers. See <a href="#">2.15.3 [Error Injection and Simulation]</a> . See <a href="#">2.15.1 [Machine Check Architecture]</a> .<br><ul style="list-style-type: none"> <li>1=MCi_STATUS registers are read-write, including reserved fields; do not cause general protection faults; such writes update all implemented bits in these registers; All fields of all threshold registers are Read-write when accessed from MSR space, including Locked, except BlkPtr which is always read-only; McStatusWrEn does not change the access type for the thresholding registers accessed via configuration space.</li> <li>0=MCi_STATUS registers are readable; writing a non-zero pattern to these registers causes a general protection fault.</li> <li>The MCi_STATUS registers are: <a href="#">MSR0000_0401</a>, <a href="#">MSR0000_0405</a>, <a href="#">MSR0000_0409</a>, <a href="#">MSR0000_040D</a>, <a href="#">MSR0000_0411</a>, <a href="#">MSR0000_0415</a>, <a href="#">MSR0000_0419</a>. McStatusWrEn does not affect the writability of <a href="#">MSR0000_0001</a>; <a href="#">MSR0000_0001</a> is always writable.</li> <li>The thresholding registers affected by McStatusWrEn are: <a href="#">MSR0000_0403</a>, <a href="#">MSR0000_0407</a>, <a href="#">MSR0000_040B</a>, <a href="#">MSR0000_0413</a>, <a href="#">MSR0000_0417</a>, <a href="#">MSRC000_0408</a>.</li> </ul> |
| 17    | <b>Wrap32Dis: 32-bit address wrap disable.</b> Read-write. Reset: 0. 1=Disable 32-bit address wrapping. Software can use Wrap32Dis to access physical memory above 4 Gbytes without switching into 64-bit mode. To do so, software should write a greater-than 4 Gbyte address to <a href="#">MSRC000_0100 [FS Base (FS_BASE)]</a> and <a href="#">MSRC000_0101 [GS Base (GS_BASE)]</a> . Then it would address $\pm 2$ Gbytes from one of those bases using normal memory reference instructions with a FS or GS override prefix. However, the INVLPG, FST, and SSE store instructions generate 32-bit addresses in legacy mode, regardless of the state of Wrap32Dis.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 16:15 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 14    | <b>RsmSpCycDis: RSM special bus cycle disable.</b> IF <a href="#">MSRC001_0015[SmmLock]</a> THEN Read-only ELSE Read-write ENDIF. Reset: 0. 0=A link special bus cycle, SMIACK, is generated on a resume from SMI.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 13    | <b>SmiSpCycDis: SMI special bus cycle disable.</b> IF <a href="#">MSRC001_0015[SmmLock]</a> THEN Read-only ELSE Read-write ENDIF. Reset: 0. 0=A link special bus cycle, SMIACK, is generated when an SMI interrupt is taken.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| 12    | <b>HltXSpCycEn: halt-exit special bus cycle enable.</b> Read-write. Reset: 0. BIOS: 1. Read-write. Specifies whether a halt exit special bus cycle is sent to the Northbridge when exiting from the halt state. 1=Messages are sent. 0=Messages are not sent. See <a href="#">2.5.3.2.4.1 [FCH Messaging]</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| 11    | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |

|     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|-----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 10  | <b>MonMwaitUserEn: MONITOR/MWAIT user mode enable.</b> Read-write. Reset: 0. 1=The MONITOR and MWAIT instructions are supported in all privilege levels. 0=The MONITOR and MWAIT instructions are supported only in privilege level 0; these instructions in privilege levels 1 to 3 cause a #UD exception. The state of this bit is ignored if MonMwaitDis is set.                                                                                                                                                                        |
| 9   | <b>MonMwaitDis: MONITOR and MWAIT disable.</b> Read-write. Reset: 0. 1=The MONITOR and MWAIT opcodes become invalid. This affects what is reported back through <a href="#">CPUID Fn0000_0001_ECX[Monitor]</a> .                                                                                                                                                                                                                                                                                                                           |
| 8   | <b>IgnneEm: IGNNE port emulation enable.</b> Read-write. Reset: 0. 1=Enable emulation of IGNNE port.                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 7:6 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 5   | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 4   | <b>INVDWBINVD: INVD to WBINVD conversion.</b> Read-write. Reset: 1. 1=Convert INVD to WBINVD. BIOS: See <a href="#">2.3.3 [Using L2 Cache as General Storage During Boot]</a> . This bit is required to be set for normal operation when both cores of a compute unit are enabled, and thus share the L2 cache or when an L3 exists.                                                                                                                                                                                                       |
| 3   | <b>TlbCacheDis: cacheable memory disable.</b> Read-write. Reset: 0. 1=Disable performance improvement that assumes that the PML4, PDP, PDE and PTE entries are in cacheable WB DRAM. Operating systems that maintain page tables in any other memory type must set the TlbCacheDis bit to insure proper operation. <ul style="list-style-type: none"> <li>• TlbCacheDis does not override the memory type specified by the SMM ASeg and TSeg memory regions. See <a href="#">2.4.9.2.7 [The Protected ASeg and TSeg Areas]</a>.</li> </ul> |
| 2   | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 1   | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 0   | <b>SmmLock: SMM code lock.</b> Read; write-1-only. Reset: 0. SBIOS: 1. 1=SMM code in the ASeg and TSeg range and the SMM registers are read-only and SMI interrupts are not intercepted in SVM. See <a href="#">2.4.9.2.9 [Locking SMM]</a> .                                                                                                                                                                                                                                                                                              |

### MSRC001\_00[18,16] IO Range Base (IORR\_BASE[1:0])

**Per-compute-unit.** Reset: X. MSRC001\_0016 and MSRC001\_0017 combine to specify the first IORR range and MSRC001\_0018 and MSRC001\_0019 combine to specify the second IORR range. A core access, with address CPUAddr, is determined to be within IORR address range if the following equation is true:

$\text{CPUAddr}[47:12] \& \text{PhyMask}[47:12] == \text{PhyBase}[47:12] \& \text{PhyMask}[47:12]$ .

BIOS can use the IORRs to create an IO hole within a range of addresses that would normally be mapped to DRAM. It can also use the IORRs to re-assert a DRAM destination for a range of addresses that fall within a bigger IO hole that overlays DRAM. See [2.4.6.1.2 \[Determining The Access Destination for Core Accesses\]](#).

| Bits  | Description                                                                                                                                              |
|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| 63:48 | RAZ.                                                                                                                                                     |
| 47:12 | <b>PhyBase: physical base address.</b> Read-write.                                                                                                       |
| 11:5  | RAZ.                                                                                                                                                     |
| 4     | <b>RdMem: read from memory.</b> Read-write. 1=Read accesses to the range are directed to system memory. 0=Read accesses to the range are directed to IO. |

|     |                                                                                                                                                           |
|-----|-----------------------------------------------------------------------------------------------------------------------------------------------------------|
| 3   | <b>WrMem: write to memory.</b> Read-write. 1=Write accesses to the range are directed to system memory. 0=Write accesses to the range are directed to IO. |
| 2:0 | RAZ.                                                                                                                                                      |

### MSRC001\_00[19,17] IO Range Mask (IORR\_MASK[1:0])

[Per-compute-unit.](#)

Reset: 0000\_0000\_0000\_0000h. See [MSRC001\\_00\[18,16\]](#).

| Bits  | Description                                                                              |
|-------|------------------------------------------------------------------------------------------|
| 63:48 | RAZ.                                                                                     |
| 47:12 | <b>PhyMask: physical address mask.</b> Read-write.                                       |
| 11    | <b>Valid.</b> Read-write. 1=The pair of registers that specifies an IORR range is valid. |
| 10:0  | RAZ.                                                                                     |

### MSRC001\_001A Top Of Memory (TOP\_MEM)

[Per-compute-unit.](#)

Reset: 0000\_0000\_0000\_0000h.

| Bits  | Description                                                                                                                                                                                                                                                                                   |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 63:48 | RAZ.                                                                                                                                                                                                                                                                                          |
| 47:23 | <b>TOM[47:23]: top of memory.</b> Read-write. Specifies the address that divides between MMIO and DRAM. This value is normally placed below 4G. From TOM to 4G is MMIO; below TOM is DRAM. See <a href="#">2.4.6 [System Address Map]</a> and <a href="#">2.9.13 [DRAM CC6/PC6 Storage]</a> . |
| 22:0  | RAZ.                                                                                                                                                                                                                                                                                          |

### MSRC001\_001D Top Of Memory 2 (TOM2)

[Per-compute-unit.](#)

Reset: 0000\_0000\_0000\_0000h.

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                       |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 63:48 | RAZ.                                                                                                                                                                                                                                                                                                                                                                              |
| 47:23 | <b>TOM2[47:23]: second top of memory.</b> Read-write. Specifies the address divides between MMIO and DRAM. This value is normally placed above 4G. From 4G to TOM2 - 1 is DRAM; TOM2 and above is MMIO. See <a href="#">2.4.6 [System Address Map]</a> and <a href="#">2.9.13 [DRAM CC6/PC6 Storage]</a> . This register is enabled by <a href="#">MSRC001_0010[MtrrTom2En]</a> . |
| 22:0  | RAZ.                                                                                                                                                                                                                                                                                                                                                                              |

### MSRC001\_001F Northbridge Configuration 1 (NB\_CFG1)

Read-write; [Per-node](#). Only one of these registers exists in multi-core devices; see [3.1.1 \[Northbridge MSRs In Multi-Core Products\]](#). [MSRC001\\_001F\[31:0\]](#) is an alias of [D18F3x88](#). [MSRC001\\_001F\[63:32\]](#) is an alias of [D18F3x8C](#).

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 63    | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 62    | <b>DisStpClkAbortFlush</b> . Reset: 0.<br>1=Disable aborting flush for core when the other core has a pending architectural interrupt.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 61:56 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 55    | <b>EnaDiv1CpuLowPwr</b> . Reset: 0.<br>Enables power management actions in the core even when the requested clock divisor is /1. Normally a /1 clock divisor does not generate power management actions.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 54    | <b>InitApicIdCpuIdLo</b> . Reset: 0. BIOS: 1.<br>0=Reserved. 1=Selects the format for ApicId; see <a href="#">APIC20</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| 53:52 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 51    | <b>DisDatFwdVic</b> . Reset: 0.<br>1=Disables data forwarding from victims to reads.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 50    | <b>DisOrderRdRsp</b> . Reset: 0. 1=Disables ordered responses to IO link read requests.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 49:47 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 46    | <b>EnableCf8ExtCfg: enable CF8 extended configuration cycles</b> . Reset: 0. 1=Allows the IO configuration space access method, <a href="#">IOCF8</a> and <a href="#">IOCFC</a> , to be used to generate extended configuration cycles by enabling <a href="#">IOCF8</a> [27:24].                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 45    | <b>DisUsSysMgtReqToNcHt: disable upstream system management request to link</b> . Reset: 0.<br>1=Disables downstream reflection of upstream STPCLK and x86 legacy input system management commands (in order to work around potential deadlock scenarios related to reflection regions).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 44:37 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 36    | <b>DisDatMsk: disable data mask</b> . Reset: 0. BIOS: IF ( <a href="#">DataMaskMbType</a> !=1) THEN 1 ELSE 0 ENDIF. 1=Disables DRAM data masking function; all write requests that are less than one cacheline, a DRAM read is performed before writing the data. Data masking is supported in ECC mode; the NB performs a minimum write size of 16B.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| 35:32 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 31    | <b>DisCohLdtCfg: disable coherent link configuration accesses</b> . Reset: 0. 1=Disables automatic routing of PCI configuration accesses to the processor configuration registers; PCI configuration space accesses which fall within the hard-coded range reserved for processor configuration-space registers are instead routed to the IO link specified by <a href="#">D18F1x[1DC:1D0,EC:E0]</a> [ <a href="#">Configuration Map</a> ]. This can be used to effectively hide the configuration registers from software. It can also be used to provide a means for an external chip to route processor configuration accesses according to a scheme other than the hard-coded version. When used, this bit needs to be set on all processors in a system. PCI configuration accesses should not be generated if this bit is not set on all processors. |
| 30:28 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |

|       |                                                                                                                                                                                                                                                                         |
|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 27    | <b>DisDramScrub.</b> Reset: 0. BIOS: 1. 1=Disable DRAM ECC scrubbing; this overrides the settings in <a href="#">D18F3x58 [Scrub Rate Control]</a> , <a href="#">D18F3x5C [DRAM Scrub Address Low]</a> .                                                                |
| 26:19 | Reserved.                                                                                                                                                                                                                                                               |
| 18    | <b>DisCstateBoostBlockPstateUp.</b> Read-write. Reset: 0. BIOS:1. 1=Allow cores that are waking up out of a non-C0 C-state to transition to the last requested Pstate without having to wait for cores in the boosted P-state to transition out of the boosted P-state. |
| 17:0  | Reserved.                                                                                                                                                                                                                                                               |

### MSRC001\_0022 Machine Check Exception Redirection

Reset: 0000\_0000\_0000\_0000h. This register can be used to redirect machine check exceptions (MCEs) to SMIs or vectored interrupts. If both RedirSmiEn and RedirVecEn are set, then undefined behavior results.

| Bits  | Description                                                                                                                                                                                                           |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 63:32 | Reserved.                                                                                                                                                                                                             |
| 31:10 | Reserved.                                                                                                                                                                                                             |
| 9     | <b>RedirSmiEn.</b> Read-write. 1=Redirect MCEs (that are directed to this core) to generate an SMI-trigger IO cycle via <a href="#">MSRC001_0056</a> . The status is stored in <a href="#">SMMFEC4[MceRedirSts]</a> . |
| 8     | <b>RedirVecEn.</b> Read-write. 1=Redirect MCEs (that are directed to this core) to generate a vectored interrupt, using the interrupt vector specified in RedirVector.                                                |
| 7:0   | <b>RedirVector.</b> Read-write. See RedirVecEn.                                                                                                                                                                       |

### MSRC001\_00[35:30] Processor Name String

[Per-compute-unit](#); [SharedNC](#).

Reset: 0000\_0000\_0000\_0000h. BIOS: [Table 247](#). These registers holds the CPUID name string in ASCII. The state of these registers are returned by CPUID instructions, [CPUID Fn8000\\_000\[4:2\]\\_E\[D,C,B,A\]X](#). BIOS should set these registers to the product name for the processor as provided by AMD. Each register contains a block of 8 ASCII characters; the least byte corresponds to the first ASCII character of the block; the most-significant byte corresponds to the last character of the block. MSRC001\_0030 contains the first block of the name string; MSRC001\_0035 contains the last block of the name string.

Table 246: [Register Mapping](#) for [MSRC001\\_00\[35:30\]](#)

| Register     | Function         |
|--------------|------------------|
| MSRC001_0030 | Characters 7-0   |
| MSRC001_0031 | Characters 15-8  |
| MSRC001_0032 | Characters 23-16 |
| MSRC001_0033 | Characters 31-24 |
| MSRC001_0034 | Characters 39-32 |
| MSRC001_0035 | Characters 47-40 |

See [D18F5x194](#) for the access method to [D18F5x198\\_x\[B:0\]](#).

**Table 247: BIOS Recommendations for MSRC001\_00[35:30]**

| Register     | BIOS                         |
|--------------|------------------------------|
| MSRC001_0030 | {D18F5x198_x1, D18F5x198_x0} |
| MSRC001_0031 | {D18F5x198_x3, D18F5x198_x2} |
| MSRC001_0032 | {D18F5x198_x5, D18F5x198_x4} |
| MSRC001_0033 | {D18F5x198_x7, D18F5x198_x6} |
| MSRC001_0034 | {D18F5x198_x9, D18F5x198_x8} |
| MSRC001_0035 | {D18F5x198_xB, D18F5x198_xA} |

| Bits | Description                        |
|------|------------------------------------|
| 63:0 | <b>CpuNameString</b> . Read-write. |

**MSRC001\_003E Hardware Thermal Control (HTC)**

Only one of these registers exists in multi-core devices; see 3.1.1 [Northbridge MSRs In Multi-Core Products]. Uses hardware P-state numbering. See 2.5.3.1.1.2 [Hardware P-state Numbering].

| Bits  | Description                                                                                                                                                                                                                                                     |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 63:32 | Reserved.                                                                                                                                                                                                                                                       |
| 31    | Reserved.                                                                                                                                                                                                                                                       |
| 30:28 | <b>HtcPstateLimit</b> : HTC P-state limit select. <a href="#">MSRC001_003E[HtcPstateLimit]</a> is an alias of <a href="#">D18F3x64[HtcPstateLimit]</a> . <a href="#">MSRC001_003E[HtcPstateLimit]</a> is an alias of <a href="#">D18F3x64[HtcPstateLimit]</a> . |
| 27:24 | <b>HtcHystLmt</b> : HTC hysteresis. <a href="#">MSRC001_003E[HtcHystLmt]</a> is an alias of <a href="#">D18F3x64[HtcHystLmt]</a> .                                                                                                                              |
| 23    | <b>HtcSlewSel</b> : HTC slew-controlled temperature select. <a href="#">MSRC001_003E[HtcSlewSel]</a> is an alias of <a href="#">D18F3x64[HtcSlewSel]</a> .                                                                                                      |
| 22:16 | <b>HtcTmpLmt</b> : HTC temperature limit. <a href="#">MSRC001_003E[HtcTmpLmt]</a> is an alias of <a href="#">D18F3x64[HtcTmpLmt]</a> .                                                                                                                          |
| 15:8  | Reserved.                                                                                                                                                                                                                                                       |
| 7     | <b>PslApicLoEn</b> : P-state limit lower value change APIC interrupt enable. <a href="#">MSRC001_003E[PslApicLoEn]</a> is an alias of <a href="#">D18F3x64[PslApicLoEn]</a> .                                                                                   |
| 6     | <b>PslApicHiEn</b> : P-state limit higher value change APIC interrupt enable. <a href="#">MSRC001_003E[PslApicHiEn]</a> is an alias of <a href="#">D18F3x64[PslApicHiEn]</a> .                                                                                  |
| 5     | <b>HtcActSts</b> : HTC-active status. <a href="#">MSRC001_003E[HtcActSts]</a> is an alias of <a href="#">D18F3x64[HtcActSts]</a> .                                                                                                                              |
| 4     | <b>HtcAct</b> : HTC-active state. <a href="#">MSRC001_003E[HtcAct]</a> is an alias of <a href="#">D18F3x64[HtcAct]</a> .                                                                                                                                        |
| 3:1   | Reserved.                                                                                                                                                                                                                                                       |
| 0     | <b>HtcEn</b> : HTC enable. <a href="#">MSRC001_003E[HtcEn]</a> is an alias of <a href="#">D18F3x64[HtcEn]</a> .                                                                                                                                                 |

**MSRC001\_0044 DC Machine Check Control Mask (MC0\_CTL\_MASK)**

Read-write. Reset: 0000\_0000\_0000\_0000h. BIOS: 0000\_0000\_0000\_0000h. See 2.15.1 [Machine Check Architecture]. See [MSR0000\\_0400 \[MC0 Machine Check Control \(MC0\\_CTL\)\]](#).

| Bits  | Description                                                           |
|-------|-----------------------------------------------------------------------|
| 63:12 | Reserved.                                                             |
| 11    | Reserved.                                                             |
| 10    | Reserved.                                                             |
| 9     | Reserved.                                                             |
| 8     | <b>IntErrType2: internal error type 2.</b>                            |
| 7     | <b>SRDE: read data errors.</b> System read data errors on cache fill. |
| 6     | <b>LFE: line fill error.</b> Uncorrectable error on cache fill.       |
| 5     | <b>SCBP: SCB parity.</b>                                              |
| 4     | <b>SQP: store queue parity.</b>                                       |
| 3     | <b>LQP: load queue parity.</b>                                        |
| 2     | <b>DatP: data parity.</b>                                             |
| 1     | <b>TLBP: TLB parity.</b>                                              |
| 0     | <b>TagP: tag parity.</b>                                              |

#### MSRC001\_0045 IC Machine Check Control Mask (MC1\_CTL\_MASK)

Read-write; [Per-compute-unit](#). Reset: 0000\_0000\_0000\_0080h. BIOS: 0000\_0000\_0000\_0080h. See [2.15.1 \[Machine Check Architecture\]](#). See [MSR0000\\_0404 \[MC1 Machine Check Control \(MC1\\_CTL\)\]](#).

| Bits  | Description                                            |
|-------|--------------------------------------------------------|
| 63:26 | Reserved.                                              |
| 25    | Unused.                                                |
| 24    | Reserved.                                              |
| 23    | <b>IVP: IC valid bit parity error.</b>                 |
| 22    | <b>L1TLBM: IC L1 TLB multi-match error.</b>            |
| 21    | <b>L2TLBM: IC L2 TLB multi-match error.</b>            |
| 20    | <b>DFIFOE: decoder FIFO parity error.</b>              |
| 19    | <b>DPDBE: decoder predecode buffer parity error.</b>   |
| 18    | <b>DEIBP: decoder instruction buffer parity error.</b> |
| 17    | <b>DEUOPQP: Decoder micro-op queue parity error.</b>   |
| 16    | <b>DEPRP: microcode patch buffer parity error.</b>     |
| 15    | <b>BSRP: branch status register parity error.</b>      |
| 14    | Reserved.                                              |
| 13    | <b>PQP: prediction queue parity error.</b>             |
| 12    | <b>PFBP: prefetch buffer parity.</b>                   |
| 11:10 | Reserved.                                              |



|     |                                                     |
|-----|-----------------------------------------------------|
| 9   | <b>SRDE: system read data error.</b>                |
| 8   | Reserved.                                           |
| 7   | <b>LineFillPoison: line fill poison error.</b>      |
| 6   | <b>L1TP: L1 TLB parity error.</b>                   |
| 5   | <b>L2TP: L2 TLB parity error.</b>                   |
| 4   | <b>ISTP: L1 cache probe tag array parity error.</b> |
| 3   | <b>IMTP: L1 cache main tag array parity error.</b>  |
| 2   | <b>IDP: L1 cache data array parity error.</b>       |
| 1:0 | Reserved.                                           |

#### MSRC001\_0046 BU Machine Check Control Mask (MC2\_CTL\_MASK)

Read-write; [Per-compute-unit](#). Reset: 0000\_0000\_0000\_0000h. BIOS: 0000\_0000\_0000\_0000h. See 2.15.1 [Machine Check Architecture]. See MSR0000\_0408 [MC2 Machine Check Control (MC2\_CTL)].

| Bits  | Description                                                                             |
|-------|-----------------------------------------------------------------------------------------|
| 63:15 | Reserved.                                                                               |
| 14    | <b>L2TlbFill: TLB fill error enable.</b> Data with uncorrectable error provided to TLB. |
| 13    | <b>RdData: read data error from NB.</b>                                                 |
| 12    | <b>L2Tag: L2 cache tag error.</b>                                                       |
| 11    | <b>L2TlbData: L2 TLB parity error.</b> Parity error reading from TLB.                   |
| 10    | <b>L2Prefetch: L2 data prefetcher parity error.</b>                                     |
| 9     | <b>XabAddr: XAB address parity error.</b>                                               |
| 8     | <b>PrbAddr: probe buffer address parity error.</b>                                      |
| 7     | <b>FillData: fill data parity and ECC error.</b>                                        |
| 6     | <b>PrqAddr: post retire queue address parity error.</b>                                 |
| 5     | <b>PrqData: post retire queue data parity error.</b>                                    |
| 4     | <b>WccAddr: write coalescing cache address ECC error.</b>                               |
| 3     | <b>WccData: write coalescing cache data ECC error.</b>                                  |
| 2     | <b>WebData: write combining buffer data parity error.</b>                               |
| 1     | <b>VbData: victim buffer data parity and ECC error.</b>                                 |
| 0     | <b>L2TagMultiHit: L2 tag multiple hit error.</b>                                        |

#### MSRC001\_0047 Reserved (MC3\_CTL\_MASK)

Reset: 0000\_0000\_0000\_0000h.

| Bits | Description |
|------|-------------|
| 63:0 | Reserved.   |

#### MSRC001\_0048 NB Machine Check Control Mask (MC4\_CTL\_MASK)

IF (D18F3x44[NbMcaToMstCpuEn] && !NBC) THEN RAZ. ELSE Read-write; [Per-node](#). ENDIF. The



format of MC4\_CTL\_MASK corresponds to [MSR0000\\_0410 \[MC4 Machine Check Control \(MC4\\_CTL\)\]](#). For each defined bit position, 1=Disable logging. Only one of these registers exists in multi-core devices; see [3.1.1 \[Northbridge MSRs In Multi-Core Products\]](#). See [2.15.1 \[Machine Check Architecture\]](#). Accessibility of this register by non-NBC cores is affected by [D18F3x44\[NbMcaToMstCpuEn\]](#). See [MSR0000\\_0410 \[MC4 Machine Check Control \(MC4\\_CTL\)\]](#).

| Bits  | Description                                                                                                                                                                                           |
|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 63:32 | Reserved.                                                                                                                                                                                             |
| 31    | <b>McaCpuDatErrEn</b> . Reset: 0. BIOS: 0.                                                                                                                                                            |
| 30    | Reserved.                                                                                                                                                                                             |
| 29    | <b>UCRCEn</b> . Reset: 0. BIOS: 0.                                                                                                                                                                    |
| 28    | <b>CCRCEn</b> . Reset: 0. BIOS: 0.                                                                                                                                                                    |
| 27    | Reserved.                                                                                                                                                                                             |
| 26    | <b>NbArrayPar</b> . Reset: 0. IF ( <a href="#">D18F4x118[NbPwrGate0]</a> ==1    <a href="#">D18F4x118[NbPwrGate1]</a> ==1    <a href="#">D18F4x11C[NbPwrGate2]</a> ==1) BIOS: 1. ELSE BIOS: 0. ENDIF. |
| 25    | <b>UsPwDatErrEn</b> . Reset: 0. BIOS: 0.                                                                                                                                                              |
| 24:18 | Reserved.                                                                                                                                                                                             |
| 17    | <b>CpPktDatEn</b> . Reset: 0. BIOS: 0.                                                                                                                                                                |
| 16    | <b>NbIntProtEn</b> . Reset: 0. BIOS: 0.                                                                                                                                                               |
| 15:13 | Reserved.                                                                                                                                                                                             |
| 12    | <b>WDTRptEn</b> . Reset: 0. BIOS: 0.                                                                                                                                                                  |
| 11    | <b>AtomicRMWEn</b> . Reset: 0. BIOS: 0.                                                                                                                                                               |
| 10    | Reserved.                                                                                                                                                                                             |
| 9     | <b>TgtAbortEn</b> . Reset: 0. BIOS: 0.                                                                                                                                                                |
| 8     | <b>MstrAbortEn</b> . Reset: 0. BIOS: 0.                                                                                                                                                               |
| 7:6   | Reserved.                                                                                                                                                                                             |
| 5     | <b>SyncPktEn</b> . Reset: 0. BIOS: 0.                                                                                                                                                                 |
| 4:2   | Reserved.                                                                                                                                                                                             |
| 1     | <b>UECCEn</b> . Reset: 0. BIOS: 0.                                                                                                                                                                    |
| 0     | <b>CECCEn</b> . Reset: 0. BIOS: 0.                                                                                                                                                                    |

#### MSRC001\_0049 EX Machine Check Control Mask (MC5\_CTL\_MASK)

Reset: 0000\_0000\_0000\_0000h. BIOS: 0000\_0000\_0000\_0000h. See [2.15.1 \[Machine Check Architecture\]](#). See [MSR0000\\_0414 \[MC5 Machine Check Control \(MC5\\_CTL\)\]](#).

| Bits | Description                                                                            |
|------|----------------------------------------------------------------------------------------|
| 63:0 | See: <a href="#">MSR0000_0414</a> . The format of MC5_CTL_MASK corresponds to MC5_CTL. |

#### MSRC001\_004A FP Machine Check Control Mask (MC6\_CTL\_MASK)

**Per-compute-unit**. Reset: 0000\_0000\_0000\_0000h. BIOS: 0000\_0000\_0000\_0000h. See [2.15.1 \[Machine Check Architecture\]](#). See [MSR0000\\_0418 \[MC6 Machine Check Control \(MC6\\_CTL\)\]](#).

| Bits | Description                                                                            |
|------|----------------------------------------------------------------------------------------|
| 63:0 | See: <a href="#">MSR0000_0418</a> . The format of MC6_CTL_MASK corresponds to MC6_CTL. |

### **MSRC001\_00[53:50] IO Trap (SMI\_ON\_IO\_TRAP\_[3:0])**

Per-compute-unit; SharedNC.

Reset: 0000\_0000\_0000\_0000h.

[MSRC001\\_00\[53:50\]](#) and [MSRC001\\_0054](#) provide a mechanism for executing the SMI handler if a an access to one of the specified addresses is detected. Access address and access type checking is performed before IO instruction execution. If the access address and access type match one of the specified IO address and access types, then: (1) the IO instruction is not executed; (2) any breakpoint, other than the single-step breakpoint, set on the IO instruction is not taken (the single-step breakpoint is taken after resuming from SMM); and (3) the SMI-trigger IO cycle specified by [MSRC001\\_0056](#). The status is stored in [SMMFEC4\[IoTrapSts\]](#).

IO-space configuration accesses are special IO accesses. An IO access is defined as an IO-space configuration access when IO instruction address bits[31:0] are CFCh, CFDh, CFEh, or CFFh when IO-space configuration is enabled ([IOCF8\[ConfigEn\]](#)). The access address for a configuration space access is the current value of [IOCF8\[BusNo, Device, Function, RegNo\]](#). The access address for an IO access that is not a configuration access is equivalent to the IO instruction address, bits[31:0].

The access address is compared with SmiAddr, and the instruction access type is compared with the enabled access types defined by ConfigSMI, SmiOnRdEn, and SmiOnWrEn. Access address bits[23:0] can be masked with SmiMask.

IO and configuration space trapping to SMI applies only to single IO instructions; it does not apply to string and REP IO instructions.

The conditional GP fault described by [MSRC001\\_0015\[IoCfgGpFault\]](#) takes priority over this trap.

Table 248: [Register Mapping](#) for [MSRC001\\_00\[53:50\]](#)

| Register     | Function |
|--------------|----------|
| MSRC001_0050 | Range 0  |
| MSRC001_0051 | Range 1  |
| MSRC001_0052 | Range 2  |
| MSRC001_0053 | Range 3  |

| Bits  | Description                                                                                                                                |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------|
| 63    | <b>SmiOnRdEn: enable SMI on IO read.</b> Read-write. 1=Enables SMI generation on a read access.                                            |
| 62    | <b>SmiOnWrEn: enable SMI on IO write.</b> Read-write. 1=Enables SMI generation on a write access.                                          |
| 61    | <b>ConfigSmi: configuration space SMI.</b> Read-write. 1=Configuration access. 0=IO access (that is not an IO-space configuration access). |
| 60:56 | Reserved.                                                                                                                                  |
| 55:32 | <b>SmiMask[23:0].</b> Read-write. SMI IO trap mask. 0=Mask address bit. 1=Do not mask address bit.                                         |
| 31:0  | <b>SmiAddr[31:0].</b> Read-write. SMI IO trap address.                                                                                     |

**MSRC001\_0054 IO Trap Control (SMI\_ON\_IO\_TRAP\_CTL\_STS)**

[Per-compute-unit](#); [SharedNC](#).

For each of the SMIEn bits below, 1=The trap specified by the corresponding MSR is enabled. See [MSRC001\\_00\[53:50\]](#).

| Bits  | Description                                                                                                                                                                           |
|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 63:32 | RAZ.                                                                                                                                                                                  |
| 31:16 | Reserved.                                                                                                                                                                             |
| 15    | <b>IoTrapEn: IO trap enable.</b> Read-write. Reset: 0. 1=Enable IO and configuration space trapping specified by <a href="#">MSRC001_00[53:50]</a> and <a href="#">MSRC001_0054</a> . |
| 14:8  | Reserved.                                                                                                                                                                             |
| 7     | <b>SmiEn3: SMI enable for the trap specified by MSRC001_0053.</b> Read-write. Reset: 0.                                                                                               |
| 6     | Reserved.                                                                                                                                                                             |
| 5     | <b>SmiEn2: SMI enable for the trap specified by MSRC001_0052.</b> Read-write. Reset: 0.                                                                                               |
| 4     | Reserved.                                                                                                                                                                             |
| 3     | <b>SmiEn1: SMI enable for the trap specified by MSRC001_0051.</b> Read-write. Reset: 0.                                                                                               |
| 2     | Reserved.                                                                                                                                                                             |
| 1     | <b>SmiEn0: SMI enable for the trap specified by MSRC001_0050.</b> Read-write. Reset: 0.                                                                                               |
| 0     | Reserved.                                                                                                                                                                             |

**MSRC001\_0055 Interrupt Pending**

[Per-compute-unit](#); [SharedNC](#). This register is used to specify messages that the processor generates under certain conditions, that target the IO hub. One purpose is to ensure that the IO hub can wake the processor out of the stop-grant state when there is a pending interrupt. Otherwise, it is possible for the processor to remain in the stop-grant state while an interrupt is pending in the processor. This is accomplished by sending a message to the IO hub to indicate that the interrupt is pending. There are two message types: a programmable IO-space message and the link INT\_PENDING message defined by the link specification.

If the IO hub does not support the INT\_PENDING message, the IO space message should be selected by IntPndMsg. When this is enabled, the check for a pending interrupt is performed at the end of each IO instruction. If there is a pending interrupt and STPCLK is asserted, the processor executes a byte-size IO access as specified by IORd, IOMsgAddr, and IOMsgData.

If the IO hub supports the INT\_PENDING message, it should be selected by IntPndMsg. The check for a pending interrupt is performed while in the stop-grant state or when entering the stop-grant state. If there is a pending interrupt, the processor broadcasts the INT\_PENDING message. An INT\_PENDING message may not be generated for arbitrated interrupts in multi-node systems.

| Bits  | Description                                                                                                                                                                                             |
|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 63:32 | RAZ.                                                                                                                                                                                                    |
| 31    | Reserved.                                                                                                                                                                                               |
| 30    | <b>EnablePmTmrCheckLoop.</b> Read-write. Reset: 0. 1=The core loops on IO-space read accesses to the address specified by IOMsgAddr until the data value has incremented from the previous read access. |
| 29:27 | Reserved.                                                                                                                                                                                               |

|       |                                                                                                                                                                                                                                                                  |
|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 26    | <b>IORd: IO Read.</b> Read-write. Reset: 0. 1=IO read. 0=IO write.                                                                                                                                                                                               |
| 25    | <b>IntPndMsg: interrupt pending message.</b> Read-write. Reset: 0. Selects the interrupt pending message type. 0=Link-defined INT_PENDING message; 1=Programmable SMI-trigger IO-space message. The status is stored in <a href="#">SMMFEC4[IntPendSmiSts]</a> . |
| 24    | <b>IntPndMsgDis: interrupt pending message disable.</b> Read-write. Reset: 0. Disable generating the interrupt pending message specified by IntPndMsg.                                                                                                           |
| 23:16 | <b>IOMsgData: IO message data.</b> Read-write. Reset: 0. IO write message data. This field is only used if IORd specifies an IO write message.                                                                                                                   |
| 15:0  | <b>IOMsgAddr: IO message address.</b> Read-write. Reset: 0. IO space message address.                                                                                                                                                                            |

### MSRC001\_0056 SMI Trigger IO Cycle

**Not-same-for-all.** Reset: 0000\_0000\_0000\_0000h. See [2.4.9.2.3 \[SMI Sources And Delivery\]](#). This register specifies an IO cycle that may be generated when a local SMI trigger event occurs. If IoCycleEn is set and there is a local SMI trigger event, then the IO cycle generated is a byte read or write, based on IoRd, to address IoPortAddress. If the cycle is a write, then IoData contains the data written. If the cycle is a read, the value read is discarded. If IoCycleEn is clear and a local SMI trigger event occurs, then undefined behavior results.

| Bits  | Description                                                                                           |
|-------|-------------------------------------------------------------------------------------------------------|
| 63:32 | Reserved.                                                                                             |
| 31:27 | Reserved.                                                                                             |
| 26    | <b>IoRd: IO Read.</b> Read-write. 1=IO read; 0=IO write.                                              |
| 25    | <b>IoCycleEn: IO cycle enable.</b> Read-write. 1=The SMI trigger IO cycle is enabled to be generated. |
| 24    | Reserved.                                                                                             |
| 23:16 | <b>IoData.</b> Read-write.                                                                            |
| 15:0  | <b>IoPortAddress.</b> Read-write.                                                                     |

### MSRC001\_0058 MMIO Configuration Base Address

**Same-for-all.** See [2.7 \[Configuration Space\]](#) for a description of MMIO configuration space.

| Bits  | Description                                                                                                                                                   |
|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 63:48 | RAZ.                                                                                                                                                          |
| 47:20 | <b>MmioCfgBaseAddr[47:20]: MMIO configuration base address bits[47:20].</b> Read-write. Reset: X. Specifies the base address of the MMIO configuration range. |
| 19:6  | RAZ.                                                                                                                                                          |

|     |                                                                                                                                                                                                               |                    |                        |
|-----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|------------------------|
| 5:2 | <b>BusRange: bus range identifier.</b> Read-write. Reset: 0. Specifies the number of buses in the MMIO configuration space range. The size of the MMIO configuration space is 1 MB times the number of buses. |                    |                        |
|     | <u>Bits</u>                                                                                                                                                                                                   | <u>Description</u> | <u>BitsDescription</u> |
|     | 0h                                                                                                                                                                                                            | 1                  | 5h32                   |
|     | 1h                                                                                                                                                                                                            | 2                  | 6h64                   |
|     | 2h                                                                                                                                                                                                            | 4                  | 7h128                  |
|     | 3h                                                                                                                                                                                                            | 8                  | 8h256                  |
|     | 4h                                                                                                                                                                                                            | 16                 | Fh-9hReserved          |
| 1   | Reserved.                                                                                                                                                                                                     |                    |                        |
| 0   | <b>Enable.</b> Read-write. Reset: 0. 1=MMIO configuration space is enabled.                                                                                                                                   |                    |                        |

### MSRC001\_0060 BIST Results

Read; GP-write. Reset: 0000\_0000\_xxxx\_xxxxh. This register provides BIST results after each reset. The results provided here are identical to the values provided in EAX. If (MSRC001\_0060[29:0]=0000\_0000h) then no BIST failures were detected.

|       |                     |
|-------|---------------------|
| Bits  | Description         |
| 63:32 | Reserved.           |
| 31:0  | <b>BistResults.</b> |

### MSRC001\_0061 P-state Current Limit

Read; GP-write; [Per-compute-unit](#); updated-by-hardware. See [2.5.3 \[CPU Power Management\]](#).

|      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Bits | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 63:7 | RAZ.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 6:4  | <b>PstateMaxVal: P-state maximum value.</b> Specifies the lowest-performance non-boosted P-state (highest non-boosted value) allowed. Attempts to change <a href="#">MSRC001_0062[PstateCmd]</a> to a lower-performance P-state (higher value) are clipped to the value of this field. This field uses software P-state numbering. See <a href="#">2.5.3.1.1.1 [Software P-state Numbering]</a> .                                                                                                                                      |
| 3    | RAZ.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 2:0  | <b>CurPstateLimit: current P-state limit.</b> Specifies the highest-performance non-boosted P-state (lowest value) allowed. CurPstateLimit is always bounded by <a href="#">MSRC001_0061[PstateMaxVal]</a> . Attempts to change the CurPstateLimit to a value greater (lower performance) than <a href="#">MSRC001_0061[PstateMaxVal]</a> leaves CurPstateLimit unchanged. This field uses software P-state numbering. See <a href="#">MSRC001_0071[CurPstateLimit]</a> and <a href="#">2.5.3.1.1.1 [Software P-state Numbering]</a> . |

**MSRC001\_0062 P-state Control**

| Bits | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 63:3 | MBZ.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| 2:0  | <b>PstateCmd: P-state change command.</b> Read-write; <a href="#">Not-same-for-all</a> . Cold reset value varies by product; after a warm reset, value initializes to the P-state the core was in prior to the reset. Writes to this field cause the core to change to the indicated non-boosted P-state number, specified by <a href="#">MSRC001_00[6B:64]</a> . 0=P0, 1=P1, etc. P-state limits are applied to any P-state requests made through this register. Reads from this field return the last written value, regardless of whether any limits are applied. This field uses software P-state numbering. See <a href="#">2.5.3 [CPU Power Management]</a> and <a href="#">2.5.3.1.1.1 [Software P-state Numbering]</a> . |

**MSRC001\_0063 P-state Status**

Read; GP-write; [Per-compute-unit](#); Updated-by-hardware.

| Bits | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 63:3 | RAZ.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 2:0  | <b>CurPstate: current P-state.</b> Cold reset: Varies by product. This field provides the frequency component of the current non-boosted P-state of the core (regardless of the source of the P-state change, including <a href="#">MSRC001_0062[PstateCmd]</a> ; see <a href="#">2.5.3.1.5 [Core P-state Transition Behavior]</a> for information on how these interact). 0=P0, 1=P1, etc. The value of this field is updated when the COF transitions to a new value associated with a P-state. This field uses software P-state numbering. See <a href="#">2.5.3 [CPU Power Management]</a> and <a href="#">2.5.3.1.1.1 [Software P-state Numbering]</a> . |

**MSRC001\_00[6B:64] P-state [7:0]**

[Per-node](#). Cold reset: Varies by product. Each of these registers specify the frequency and voltage associated with each of the core P-states.

Table 249: [Register Mapping](#) for [MSRC001\\_00\[6B:64\]](#)

| Register     | Function  |
|--------------|-----------|
| MSRC001_0064 | P-state 0 |
| MSRC001_0065 | P-state 1 |
| MSRC001_0066 | P-state 2 |
| MSRC001_0067 | P-state 3 |
| MSRC001_0068 | P-state 4 |
| MSRC001_0069 | P-state 5 |
| MSRC001_006A | P-state 6 |
| MSRC001_006B | P-state 7 |

The CpuVid field in these registers is required to be programmed to the same value in all cores of a processor, but are allowed to be different between processors in a multi-processor system. All other fields in these registers are required to be programmed to the same value in each core of the coherent fabric. See [2.5.3 \[CPU Power Management\]](#).

When [D18F4x15C\[BoostLock\]=1](#), [MSRC001\\_00\[6B:64\]\[CpuVid, CpuDid, CpuFid\]](#) have special write

requirements associated with them.

**Table 250: P-state Definitions**

| Term           | Definition                                                                                                                                                                 |
|----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>CoreCOF</b> | Core current operating frequency in MHz. $\text{CoreCOF} = 100 * (\text{MSRC001\_00}[6B:64][\text{CpuFid}[5:0]] + 10h) / (2^{\text{MSRC001\_00}[6B:64][\text{CpuDid}]})$ . |

| Bits          | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |               |                    |     |                                    |     |                                      |     |                                       |     |          |
|---------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|--------------------|-----|------------------------------------|-----|--------------------------------------|-----|---------------------------------------|-----|----------|
| 63            | <b>PstateEn.</b> Read-write. 1=The P-state specified by this MSR is valid. 0=The P-state specified by this MSR is not valid. The purpose of this register is to indicate if the rest of the P-state information in the register is valid after a reset; it controls no hardware.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |               |                    |     |                                    |     |                                      |     |                                       |     |          |
| 62:42         | RAZ.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |               |                    |     |                                    |     |                                      |     |                                       |     |          |
| 41:40         | <b>IddDiv: current divisor.</b> Read-write. See IddValue.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |               |                    |     |                                    |     |                                      |     |                                       |     |          |
| 39:32         | <b>IddValue: current value.</b> Read-write. After a reset, IddDiv and IddValue combine to specify the expected maximum current dissipation of a single core that is in the P-state corresponding to the MSR number. These values are intended to be used to create ACPI-defined _PSS objects (see <a href="#">2.5.3.1.8.3 [ACPI Processor P-state Objects]</a> ) and to perform the <a href="#">2.5.3.1.7 [Processor-Systemboard Power Delivery Compatibility Check]</a> . The values are expressed in amps; they are not intended to convey final product power levels; they may not match the power levels specified in the Power and Thermal Datasheets. These fields are encoded as follows: <table> <tr> <th><u>IddDiv</u></th><th><u>Description</u></th></tr> <tr> <td>00b</td><td>IddValue / 1 A, Range: 0 to 255 A.</td></tr> <tr> <td>01b</td><td>IddValue / 10 A, Range: 0 to 25.5 A.</td></tr> <tr> <td>10b</td><td>IddValue / 100 A, Range: 0 to 2.55 A.</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table> | <u>IddDiv</u> | <u>Description</u> | 00b | IddValue / 1 A, Range: 0 to 255 A. | 01b | IddValue / 10 A, Range: 0 to 25.5 A. | 10b | IddValue / 100 A, Range: 0 to 2.55 A. | 11b | Reserved |
| <u>IddDiv</u> | <u>Description</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |               |                    |     |                                    |     |                                      |     |                                       |     |          |
| 00b           | IddValue / 1 A, Range: 0 to 255 A.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |               |                    |     |                                    |     |                                      |     |                                       |     |          |
| 01b           | IddValue / 10 A, Range: 0 to 25.5 A.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |               |                    |     |                                    |     |                                      |     |                                       |     |          |
| 10b           | IddValue / 100 A, Range: 0 to 2.55 A.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |               |                    |     |                                    |     |                                      |     |                                       |     |          |
| 11b           | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |               |                    |     |                                    |     |                                      |     |                                       |     |          |
| 31:23         | RAZ.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |               |                    |     |                                    |     |                                      |     |                                       |     |          |
| 22            | <b>NbPstate: Northbridge P-state.</b> IF ( <a href="#">MSRC001_0071</a> [NbPstateDis]) THEN Read-only. ELSE Read-write. ENDIF. 1=Low performance NB P-state. 0=High performance NB P-state. If this bit is set in any given P-state register, then it must also be set in all enabled lower performance P-state registers as well. Equivalent P-states in each core must program this bit to the same value. See <a href="#">2.5.4.1 [NB P-states]</a> and <a href="#">D18F5x170</a> [NbPstateThreshold, NbPstateLo, NbPstateHi].                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |               |                    |     |                                    |     |                                      |     |                                       |     |          |
| 21            | RAZ.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |               |                    |     |                                    |     |                                      |     |                                       |     |          |
| 20:17         | RAZ.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |               |                    |     |                                    |     |                                      |     |                                       |     |          |
| 16            | <b>CpuVid[7]: core VID bit[7].</b> Read-write. Except as required by <a href="#">2.5.3.1.7 [Processor-Systemboard Power Delivery Compatibility Check]</a> , software should not modify this field. See CpuVid[6:0].                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |               |                    |     |                                    |     |                                      |     |                                       |     |          |
| 15:9          | <b>CpuVid[6:0]: core VID.</b> Read-write. Except as required by <a href="#">2.5.3.1.7 [Processor-Systemboard Power Delivery Compatibility Check]</a> , software should not modify this field. See <a href="#">2.5.1 [Processor Power Planes And Voltage Control]</a> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |               |                    |     |                                    |     |                                      |     |                                       |     |          |



| 8:6   | <b>CpuDid: core divisor ID.</b> Read-write. Except as required by <a href="#">2.5.3.1.7 [Processor-Systemboard Power Delivery Compatibility Check]</a> , software should not modify this field. Specifies the core frequency divisor; see CpuFid. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>0h</td><td>Divide-by 1</td></tr> <tr> <td>1h</td><td>Divide-by 2</td></tr> <tr> <td>2h</td><td>Divide-by 4</td></tr> <tr> <td>3h</td><td>Divide-by 8</td></tr> <tr> <td>4h</td><td>Divide-by 16</td></tr> <tr> <td>7h-5h</td><td>Reserved</td></tr> </table> | Bits | Description | 0h | Divide-by 1 | 1h | Divide-by 2 | 2h | Divide-by 4 | 3h | Divide-by 8 | 4h | Divide-by 16 | 7h-5h | Reserved |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|----|-------------|----|-------------|----|-------------|----|-------------|----|--------------|-------|----------|
| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |      |             |    |             |    |             |    |             |    |             |    |              |       |          |
| 0h    | Divide-by 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |      |             |    |             |    |             |    |             |    |             |    |              |       |          |
| 1h    | Divide-by 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |      |             |    |             |    |             |    |             |    |             |    |              |       |          |
| 2h    | Divide-by 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |      |             |    |             |    |             |    |             |    |             |    |              |       |          |
| 3h    | Divide-by 8                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |      |             |    |             |    |             |    |             |    |             |    |              |       |          |
| 4h    | Divide-by 16                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |      |             |    |             |    |             |    |             |    |             |    |              |       |          |
| 7h-5h | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |      |             |    |             |    |             |    |             |    |             |    |              |       |          |
| 5:0   | <b>CpuFid[5:0]: core frequency ID.</b> Read-write. Except as required by <a href="#">2.5.3.1.7 [Processor-Systemboard Power Delivery Compatibility Check]</a> , software should not modify this field. Specifies the core frequency multiplier. The core COF is a function of CpuFid and CpuDid, and defined by <a href="#">CoreCOF</a> .                                                                                                                                                                                                                                   |      |             |    |             |    |             |    |             |    |             |    |              |       |          |

### MSRC001\_0070 COFVID Control

Cold reset: Product-specific. There is one register implemented for each core. This register includes several fields that are identical to [MSRC001\\_00\[6B:64\]](#). It is controlled by hardware for P-state transitions. It may also be used by software to directly control the current COF or VID.

.Accesses to this register that result in invalid COFs or VIDs are ignored. See [2.5.3 \[CPU Power Management\]](#).

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                        |
|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 63:32 | RAZ.                                                                                                                                                                                                                                                                                                                                                                               |
| 31:24 | <b>NbVid: Northbridge VID.</b> IF ( <a href="#">MSRC001_0071[NbPstateDis]</a> ) THEN Read-only. ELSE Read-write. ENDIF. See <a href="#">D18F5x16[C:0][NbVid]</a> .                                                                                                                                                                                                                 |
| 23    | RAZ.                                                                                                                                                                                                                                                                                                                                                                               |
| 22    | <b>NbPstate: Northbridge P-state.</b> IF ( <a href="#">MSRC001_0071[NbPstateDis]</a> ) THEN Read-only. ELSE Read-write. ENDIF. See <a href="#">MSRC001_00[6B:64][NbPstate]</a> .                                                                                                                                                                                                   |
| 21    | RAZ.                                                                                                                                                                                                                                                                                                                                                                               |
| 20    | <b>CpuVid[7].</b> Read-write. See CpuVid[6:0].                                                                                                                                                                                                                                                                                                                                     |
| 19    | RAZ.                                                                                                                                                                                                                                                                                                                                                                               |
| 18:16 | <b>PstateId: P-state identifier.</b> Read-write. This field is required to provide the P-state number that is associated with the values of the other fields in this register. This value is used by the logic to determine if the P-state is increasing or decreasing. This field uses hardware P-state numbering. See <a href="#">2.5.3.1.1.2 [Hardware P-state Numbering]</a> . |
| 15:9  | <b>CpuVid[6:0]: core VID.</b> Read-write. See <a href="#">MSRC001_00[6B:64][CpuVid]</a> . CpuVid[7:0] = {CpuVid[7], CpuVid[6:0]}.                                                                                                                                                                                                                                                  |
| 8:6   | <b>CpuDid: core divisor ID.</b> Read-write. See <a href="#">MSRC001_00[6B:64][CpuDid]</a> . The PstateId field must be updated to cause a new CpuDid value to take effect.                                                                                                                                                                                                         |
| 5:0   | <b>CpuFid[5:0]: core frequency ID.</b> Read-write. See <a href="#">MSRC001_00[6B:64][CpuFid]</a> . The PstateId field must be updated to cause a new CpuFid value to take effect.                                                                                                                                                                                                  |



**MSRC001\_0071 COFVID Status**

See 2.5.3 [CPU Power Management].

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 63:59 | <b>MaxNbCof: maximum NB COF.</b> Read-only. Cold reset: Product-specific. Specifies the maximum NB COF supported by the processor. If MaxNbCof is greater than zero, the maximum frequency is 100 MHz * MaxNbCof; if MaxNbCof = 00h, then there is no frequency limit. Any attempt to change the NB COF to a frequency greater than specified by this field is ignored.                                                                                 |
| 58:56 | <b>CurPstateLimit: current P-state limit.</b> Read-only; updated-by-hardware. Provides the current highest-performance P-state limit number. This register uses hardware P-state numbering. See <a href="#">MSRC001_0061[CurPstateLimit]</a> and 2.5.3.1.1.2 [Hardware P-state Numbering].                                                                                                                                                              |
| 55    | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 54:49 | <b>MaxCpuCof: maximum core COF.</b> Read-only. Cold reset: Product-specific. Specifies the maximum CPU COF supported by the processor. The maximum frequency is 100 MHz * MaxCpuCof, if MaxCpuCof is greater than zero; if MaxCpuCof = 00h, then there is no frequency limit. Any attempt to change a CPU COF to a frequency greater than specified by this field is ignored.                                                                           |
| 48:35 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 34:32 | <b>StartupPstate: startup P-state number.</b> Read-only. Cold reset: Product-specific. Specifies the cold reset VID, FID and DID for the core based on the P-state number selected. StartupPstate uses hardware P-state numbering. See <a href="#">MSRC001_00[6B:64]</a> and 2.5.3.1.1.2 [Hardware P-state Numbering].                                                                                                                                  |
| 31:24 | <b>CurNbVid[7:0]: current NB VID.</b> Read-only; updated-by-hardware. Cold reset: Product-specific. This field specifies the current VDDNB voltage. <a href="#">MSRC001_0071[CurNbVid[7:0]]</a> is an alias of <a href="#">D18F5x174[CurNbVid[7:0]]</a> .                                                                                                                                                                                               |
| 23    | <b>NbPstateDis: NB P-states disabled.</b> Value: <a href="#">D18F5x174[NbPstateDis]</a> . <a href="#">MSRC001_0071[NbPstateDis]</a> is an alias of <a href="#">D18F5x174[NbPstateDis]</a> . 0=NB P-state frequency and voltage changes are supported. See <a href="#">D18F5x170[SwNbPstateLoDis, NbPstateDisOnP0]</a> . 1=NB P-state frequency and voltage changes are disabled.                                                                        |
| 22    | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 21    | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 20    | <b>CurCpuVid[7].</b> Read-only; updated-by-hardware; not-same-for-all. Cold reset: Product-specific. See <a href="#">CurCpuVid[6:0]</a> .                                                                                                                                                                                                                                                                                                               |
| 19    | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 18:16 | <b>CurPstate: current P-state.</b> Read-only; updated-by-hardware; not-same-for-all. Cold reset: Product-specific. Specifies the current P-state requested by the core. This field uses hardware P-state numbering. See <a href="#">MSRC001_0063[CurPstate]</a> and 2.5.3.1.1.2 [Hardware P-state Numbering]. When a P-state change is requested, the value in this field is updated once all required frequency and voltage transitions are completed. |
| 15:9  | <b>CurCpuVid[6:0]: current core VID.</b> Read-only; updated-by-hardware; not-same-for-all. Cold reset: Product-specific. $\text{CurCpuVid} = \{\text{CurCpuVid}[7], \text{CurCpuVid}[6:0]\}$ . This field specifies the current VDD voltage.                                                                                                                                                                                                            |

|     |                                                                                                                                                                                                                                                                                                                                        |
|-----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 8:6 | <b>CurCpuDid: current core divisor ID.</b> Read-only; updated-by-hardware. Cold reset: Product-specific. Specifies the current CpuDid of the core. See <a href="#">MSRC001_00[6B:64]</a> . When a P-state change is requested, the value in this field is updated once all required frequency and voltage transitions are completed.   |
| 5:0 | <b>CurCpuFid: current core frequency ID.</b> Read-only; updated-by-hardware. Cold reset: Product-specific. Specifies the current CpuFid of the core. See <a href="#">MSRC001_00[6B:64]</a> . When a P-state change is requested, the value in this field is updated once all required frequency and voltage transitions are completed. |

### MSRC001\_0073 C-state Base Address

Reset: 0000\_0000\_0000\_0000h.

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 63:32 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 31:16 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 15:0  | <b>CstateAddr: C-state address.</b> Read-write. Specifies the IO addresses trapped by the core for C-state entry requests. A value of 0 in this field specifies that the core does not trap any IO addresses for C-state entry. Writing values greater than FFF8h into this field result in undefined behavior. All other values cause the core to trap IO addresses CstateAddr through CstateAddr+7. See <a href="#">2.5.3.2.2 [C-state Request Interface]</a> , <a href="#">D18F4x11[C:8]</a> , and <a href="#">D18F4x11C</a> . |

### MSRC001\_0074 CPU Watchdog Timer (CpuWdtCfg)

Read-write; [Same-for-all](#). Reset: 0000\_0000\_0000\_0000h.

The CPU watchdog timer (WDT) is implemented as a counter that counts out the time periods specified. The counter starts counting when CpuWdtEn is set. The counter does not count during halt or stop-grant. It restarts the count each time an operation of an instruction completes. If no operation completes by the specified time period, then a machine check error may be recorded if enabled (see [MSR0000\\_0414](#) through [MSR0000\\_0417](#)). If a watchdog timer error overflow occurs ([MSR0000\\_0415\[Overflow\]](#)), a sync flood can be generated if enabled in [D18F3x180\[SyncFloodOnCpuLeakErr\]](#).

The CPU watchdog timer must be set higher than the NB watchdog timer ([D18F3x44 \[MCA NB Configuration\]](#)) in order to allow remote requests to complete. The CPU watchdog timer must be set the same for all CPUs in a system.

| Bits | Description |
|------|-------------|
| 63:7 | Reserved.   |

|     |                                                                                                                                                                                                                                                                                                                                                                                                                      |                    |             |                   |
|-----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|-------------|-------------------|
| 6:3 | <b>CpuWdtCountSel: CPU watchdog timer count select.</b> CpuWdtCountSel and CpuWdtTimeBase together specify the time period required for the WDT to expire. The time period is ((the multiplier specified by CpuWdtCountSel) * (the time base specified by CpuWdtTimeBase)). The actual timeout period may be anywhere from zero to one increments less than the values specified, due to non-deterministic behavior. |                    |             |                   |
|     | <u>Bits</u>                                                                                                                                                                                                                                                                                                                                                                                                          | <u>Multiplier</u>  | <u>Bits</u> | <u>Multiplier</u> |
|     | 0h                                                                                                                                                                                                                                                                                                                                                                                                                   | 4095               | 6h          | 63                |
|     | 1h                                                                                                                                                                                                                                                                                                                                                                                                                   | 2047               | 7h          | 31                |
|     | 2h                                                                                                                                                                                                                                                                                                                                                                                                                   | 1023               | 8h          | 8191              |
|     | 3h                                                                                                                                                                                                                                                                                                                                                                                                                   | 511                | 9h          | 16383             |
|     | 4h                                                                                                                                                                                                                                                                                                                                                                                                                   | 255                | Fh-Ah       | Reserved          |
|     | 5h                                                                                                                                                                                                                                                                                                                                                                                                                   | 127                |             |                   |
| 2:1 | <b>CpuWdtTimeBase: CPU watchdog timer time base.</b> Specifies the time base for the timeout period specified in CpuWdtCountSel.                                                                                                                                                                                                                                                                                     |                    |             |                   |
|     | <u>Bits</u>                                                                                                                                                                                                                                                                                                                                                                                                          | <u>Description</u> |             |                   |
|     | 00b                                                                                                                                                                                                                                                                                                                                                                                                                  | 1.31 ms            |             |                   |
|     | 01b                                                                                                                                                                                                                                                                                                                                                                                                                  | 1.28 us            |             |                   |
|     | 10b                                                                                                                                                                                                                                                                                                                                                                                                                  | Reserved           |             |                   |
|     | 11b                                                                                                                                                                                                                                                                                                                                                                                                                  | Reserved           |             |                   |
| 0   | <b>CpuWdtEn: CPU watchdog timer enable.</b> 1=The WDT is enabled.                                                                                                                                                                                                                                                                                                                                                    |                    |             |                   |

#### MSRC001\_0111 SMM Base Address (SMM\_BASE)

Reset: 0000\_0000\_0003\_0000h. This holds the base of the SMM memory region. The value of this register is stored in the save state on entry into SMM (see 2.4.9.2.5 [SMM Save State]) and it is restored on returning from SMM. The 16-bit CS (code segment) selector is loaded with SmmBase[19:4] on entering SMM.

SmmBase[3:0] is required to be 0. The SMM base address can be changed in two ways:

- The SMM base address, at offset FF00h in the SMM state save area, may be changed by the SMI handler. The RSM instruction updates SmmBase with the new value.
- Normal WRMSR access to this register.

| Bits  | Description                                                                                                                        |
|-------|------------------------------------------------------------------------------------------------------------------------------------|
| 63:32 | Reserved.                                                                                                                          |
| 31:0  | <b>SmmBase.</b> IF MSRC001_0015[SmmLock] THEN Read-only; <b>Not-same-for-all.</b> ELSE Read-write; <b>Not-same-for-all.</b> ENDIF. |

#### MSRC001\_0112 SMM TSeg Base Address (SMMAddr)

Reset: 0000\_0000\_0000\_0000h.

See 2.4.9.2 [System Management Mode (SMM)] and 2.4.6.1 [Memory Access to the Physical Address Space]. See MSRC001\_0113 for more information about the ASeg and TSeg address ranges.

Each CPU access, directed at CPUAddr, is determined to be in the TSeg range if the following is true:

$\text{CPUAddr}[47:17] \& \text{TSegMask}[47:17] == \text{TSegBase}[47:17] \& \text{TSegMask}[47:17]$ .

For example, if TSeg spans 256 KB and starts at the 1 MB address. The MSRC001\_0112[TSegBase] would be set to 0010\_0000h and the MSRC001\_0113[TSegMask] to FFFC\_0000h (with zeros filling in for bits[16:0]).

This results in a TSeg range from 0010\_0000 to 0013\_FFFFh.

| Bits  | Description                                                                                                                      |
|-------|----------------------------------------------------------------------------------------------------------------------------------|
| 63:48 | Reserved.                                                                                                                        |
| 47:17 | <b>TSegBase[47:17]: TSeg address range base.</b> IF <a href="#">MSRC001_0015</a> [SmmLock] THEN Read-only ELSE Read-write ENDIF. |
| 16:0  | Reserved.                                                                                                                        |

### MSRC001\_0113 SMM TSeg Mask (SMMMask)

Reset: 0000\_0000\_0000\_0000h. See [2.4.9.2 \[System Management Mode \(SMM\)\]](#).

The ASeg address range is located at a fixed address from A0000h–BFFFFh. The TSeg range is located at a variable base (specified by [MSRC001\\_0112](#)[TSegBase]) with a variable size (specified by [MSRC001\\_0113](#)[TSegMask]). These ranges provide a safe location for SMM code and data that is not readily accessible by non-SMM applications. The SMI handler can be located in one of these two ranges, or it can be located outside these ranges. These ranges must never overlap each other.

This register specifies how accesses to the ASeg and TSeg address ranges are controlled as follows:

- If [A,T]Valid=1, then:
  - If in SMM, then:
    - If [A, T]Close=0, then the accesses are directed to DRAM with memory type as specified in [A, T]MTypeDram.
    - If [A, T]Close=1, then instruction accesses are directed to DRAM with memory type as specified in [A, T]MTypeDram and data accesses are directed at MMIO space and with attributes based on [A, T]MTypeIoWc.
  - If not in SMM, then the accesses are directed at MMIO space with attributes based on [A,T]MTypeIoWc.
- See [2.4.6.1.1 \[Determining Memory Type\]](#).

| Bits  | Description                                                                                                                                                                                                                                                                                             |
|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 63:48 | Reserved.                                                                                                                                                                                                                                                                                               |
| 47:17 | <b>TSegMask[47:17]: TSeg address range mask.</b> IF <a href="#">MSRC001_0015</a> [SmmLock] THEN Read-only ELSE Read-write ENDIF. See <a href="#">MSRC001_0112</a> .                                                                                                                                     |
| 16:15 | Reserved.                                                                                                                                                                                                                                                                                               |
| 14:12 | <b>TMTYPEDRAM: TSeg address range memory type.</b> IF <a href="#">MSRC001_0015</a> [SmmLock] THEN Read-only. ELSE Read-write. ENDIF. Specifies the memory type for SMM accesses to the TSeg range that are directed to DRAM. See: <a href="#">Table 216 [Valid Values for Memory Type Definition]</a> . |
| 11    | Reserved.                                                                                                                                                                                                                                                                                               |
| 10:8  | <b>AMTYPEDRAM: ASeg Range Memory Type.</b> IF <a href="#">MSRC001_0015</a> [SmmLock] THEN Read-only. ELSE Read-write. ENDIF. Specifies the memory type for SMM accesses to the ASeg range that are directed to DRAM. See: <a href="#">Table 216 [Valid Values for Memory Type Definition]</a> .         |
| 7:6   | Reserved.                                                                                                                                                                                                                                                                                               |
| 5     | <b>TMTYPEIOWC: non-SMM TSeg address range memory type.</b> IF <a href="#">MSRC001_0015</a> [SmmLock] THEN Read-only. ELSE Read-write. ENDIF. Specifies the attribute of TSeg accesses that are directed to MMIO space. 0=UC (uncacheable). 1=WC (write combining).                                      |

|   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|---|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 4 | <b>AMTypeIoWc: non-SMM ASeg address range memory type.</b> IF <a href="#">MSRC001_0015</a> [SmmLock] THEN Read-only. ELSE Read-write. ENDIF. Specifies the attribute of ASeg accesses that are directed to MMIO space. 0=UC (uncacheable). 1=WC (write combining).                                                                                                                                                                                                            |
| 3 | <b>TClose: send TSeg address range data accesses to MMIO.</b> Read-write. 1=When in SMM, direct data accesses in the TSeg address range to MMIO space. See AClose.                                                                                                                                                                                                                                                                                                            |
| 2 | <b>AClose: send ASeg address range data accesses to MMIO.</b> Read-write. 1=When in SMM, direct data accesses in the ASeg address range to MMIO space.<br><br>[A, T]Close allows the SMI handler to access the MMIO space located in the same address region as the [A, T]Seg. When the SMI handler is finished accessing the MMIO space, it must clear the bit. Failure to do so before resuming from SMM causes the CPU to erroneously read the save state from MMIO space. |
| 1 | <b>TValid: enable TSeg SMM address range.</b> IF <a href="#">MSRC001_0015</a> [SmmLock] THEN Read-only. ELSE Read-write. ENDIF. 1=The TSeg address range SMM enabled.                                                                                                                                                                                                                                                                                                         |
| 0 | <b>AValid: enable ASeg SMM address range.</b> IF <a href="#">MSRC001_0015</a> [SmmLock] THEN Read-only. ELSE Read-write. ENDIF. 1=The ASeg address range SMM enabled.                                                                                                                                                                                                                                                                                                         |

### MSRC001\_0114 Virtual Machine Control (VM\_CR)

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                             |
|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 63:32 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                               |
| 31:5  | MBZ.                                                                                                                                                                                                                                                                                                                                                                                                    |
| 4     | <b>SvmeDisable: SVM disable.</b> See Lock for the access type of this field. Reset: 0. 1= <a href="#">MSRC000_0080</a> [SVME] is MBZ. 0= <a href="#">MSRC000_0080</a> [SVME] is read-write. Attempting to set this field when ( <a href="#">MSRC000_0080</a> [SVME]==1) causes a #GP fault, regardless of the state of Lock. See the APM2 section titled “Enabling SVM” for software use of this field. |
| 3     | <b>Lock: SVM lock.</b> Read-only; write-1-only; cleared-by-hardware. Reset: 0. See <a href="#">MSRC001_0118</a> [SvmLockKey] for the condition that causes hardware to clear this field. 1=SvmeDisable is read-only. 0=SvmeDisable is read-write.                                                                                                                                                       |
| 2     | <b>DisA20m: disable A20 masking.</b> Read-write; set-by-hardware. Reset: 0. 1=Disables A20 masking. This bit is set by hardware when the SKINIT instruction is executed.                                                                                                                                                                                                                                |
| 1     | <b>InterceptInit: intercept INIT.</b> Read-write; set-by-hardware. Reset: 0. This bit controls how INIT is delivered in host mode. This bit is set by hardware when the SKINIT instruction is executed. 0=INIT delivered normally. 1=INIT translated into a SX interrupt.                                                                                                                               |
| 0     | <b>DPD: debug port disable.</b> Read-write; set-by-hardware. Reset: 0. Set by hardware when the SKINIT instruction is executed. This bit controls if debug facilities such as JTAG and HDT have access to the processor state information. 1=HDT is disabled. 0=HDT may be enabled.                                                                                                                     |

**MSRC001\_0115 IGNNE**

| Bits  | Description                                                                                                                          |
|-------|--------------------------------------------------------------------------------------------------------------------------------------|
| 63:32 | Reserved.                                                                                                                            |
| 31:1  | MBZ.                                                                                                                                 |
| 0     | <b>IGNNE: current IGNNE state.</b> Read-write. Reset: 0. This bit controls the current state of the processor internal IGNNE signal. |

**MSRC001\_0116 SMM Control (SMM\_CTL)**

IF (MSRC001\_0015[SmmLock]) THEN GP-read-write. ELSE GP-read; write-only. ENDIF.

The bits in this register are processed in the order of: SmmEnter, SmiCycle, SmmDismiss, RsmCycle and SmmExit. However, only the following combination of bits may be set in a single write (all other combinations result in undefined behavior):

- SmmEnter and SmiCycle.
- SmmEnter and SmmDismiss.
- SmmEnter, SmiCycle and SmmDismiss.
- SmmExit and RsmCycle.

Software is responsible for ensuring that SmmEnter and SmmExit operations are properly matched and are not nested.

| Bits | Description                                                          |
|------|----------------------------------------------------------------------|
| 63:5 | MBZ.                                                                 |
| 4    | <b>RsmCycle: send RSM special cycle.</b> 1=Send a RSM special cycle. |
| 3    | <b>SmmExit: exit SMM.</b> 1=Exit SMM.                                |
| 2    | <b>SmiCycle: send SMI special cycle.</b> 1=Send a SMI special cycle. |
| 1    | <b>SmmEnter: enter SMM.</b> 1=Enter SMM.                             |
| 0    | <b>SmmDismiss: clear SMI.</b> 1=Clear the SMI pending flag.          |

**MSRC001\_0117 Virtual Machine Host Save Physical Address (VM\_HSAVE\_PA)**

| Bits  | Description                                                                                                                                                                                                                                                                                          |
|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 63:48 | MBZ.                                                                                                                                                                                                                                                                                                 |
| 47:12 | <b>VM_HSAVE_PA: physical address of host save area.</b> Read-write. Reset: 0. This register contains the physical address of a 4-KB region where VMRUN saves host state and where vm-exit restores host state from. Writing this register causes a #GP if (FF_FFFF_Fh >= VM_HSAVE_PA >= FD_0000_0h). |
| 11:0  | MBZ.                                                                                                                                                                                                                                                                                                 |

**MSRC001\_0118 SVM Lock Key**

Reset: 0000\_0000\_0000\_0000h.

| Bits | Description                                                                                                                                                                                                                                                                                                                                          |
|------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 63:0 | <b>SvmLockKey: SVM lock key.</b> RAZ; write. Writes to this register when <a href="#">MSRC001_0114[Lock]</a> ==0 modify SvmLockKey. If (( <a href="#">MSRC001_0114[Lock]</a> ==1) && (SvmLockKey!=0) && (The write value==The value stored in SvmLockKey)) for a write to this register then hardware updates <a href="#">MSRC001_0114[Lock]</a> =0. |

### MSRC001\_011A Local SMI Status

Reset: 0000\_0000\_0000\_0000h. This registers returns the same information that is returned in [SMMFEC4 \[Local SMI Status\]](#) portion of the SMM save state. The information in this register is only updated when [MSRC001\\_0116\[SmmDismiss\]](#) is set by software.

| Bits  | Description                                      |
|-------|--------------------------------------------------|
| 63:32 | Reserved.                                        |
| 31:0  | See <a href="#">SMMFEC4 [Local SMI Status]</a> . |

### MSRC001\_0140 OS Visible Work-around MSR0 (OSVW\_ID\_Length)

Reset: 0000\_0000\_0000\_0000h.

| Bits  | Description                                                                                                                                                                 |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 63:16 | Reserved.                                                                                                                                                                   |
| 15:0  | <b>OSVWIdLength: OS visible work-around ID length.</b> Read-write. See the Revision Guide for the definition of this field; see <a href="#">1.2 [Reference Documents]</a> . |

### MSRC001\_0141 OS Visible Work-around MSR1 (OSVW Status)

Reset: 0000\_0000\_0000\_0000h.

| Bits | Description                                                                                                                                                                     |
|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 63:0 | <b>OsvwStatusBits: OS visible work-around status bits.</b> Read-write. See the Revision Guide for the definition of this field; see <a href="#">1.2 [Reference Documents]</a> . |

### MSRC001\_020[A,8,6,4,2,0] Performance Event Select (PERF\_CTL[5:0])

Reset: 0000\_0000\_0000\_0000h. See [2.6.1 \[Performance Monitor Counters\]](#). [MSRC001\\_00\[03:00\]](#) is an alias of [MSRC001\\_020\[6,4,2,0\]](#).

Table 251: [Register Mapping](#) for [MSRC001\\_020\[A,8,6,4,2,0\]](#)

| Register     | Function  |
|--------------|-----------|
| MSRC001_0200 | Counter 0 |
| MSRC001_0202 | Counter 1 |
| MSRC001_0204 | Counter 2 |
| MSRC001_0206 | Counter 3 |
| MSRC001_0208 | Counter 4 |
| MSRC001_020A | Counter 5 |



| Bits    | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |      |             |     |                                                                                                                                                      |         |                                                                                                                                                                                                                                                                                                                                     |         |                                                             |     |                                                                           |
|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|-----|------------------------------------------------------------------------------------------------------------------------------------------------------|---------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|-------------------------------------------------------------|-----|---------------------------------------------------------------------------|
| 63:42   | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |      |             |     |                                                                                                                                                      |         |                                                                                                                                                                                                                                                                                                                                     |         |                                                             |     |                                                                           |
| 41:40   | <b>HostGuestOnly: count only host/guest events.</b> Read-write.<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>Count all events, irrespective of guest/host.</td></tr> <tr> <td>01b</td><td>Count guest events if <a href="#">MSRC000_0080</a>[SVME]=1.</td></tr> <tr> <td>10b</td><td>Count host events if <a href="#">MSRC000_0080</a>[SVME]=1.</td></tr> <tr> <td>11b</td><td>Count all guest and host events if <a href="#">MSRC000_0080</a>[SVME]=1.</td></tr> </table>                                                                                                                                                                                                                                                                | Bits | Description | 00b | Count all events, irrespective of guest/host.                                                                                                        | 01b     | Count guest events if <a href="#">MSRC000_0080</a> [SVME]=1.                                                                                                                                                                                                                                                                        | 10b     | Count host events if <a href="#">MSRC000_0080</a> [SVME]=1. | 11b | Count all guest and host events if <a href="#">MSRC000_0080</a> [SVME]=1. |
| Bits    | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |      |             |     |                                                                                                                                                      |         |                                                                                                                                                                                                                                                                                                                                     |         |                                                             |     |                                                                           |
| 00b     | Count all events, irrespective of guest/host.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |      |             |     |                                                                                                                                                      |         |                                                                                                                                                                                                                                                                                                                                     |         |                                                             |     |                                                                           |
| 01b     | Count guest events if <a href="#">MSRC000_0080</a> [SVME]=1.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |      |             |     |                                                                                                                                                      |         |                                                                                                                                                                                                                                                                                                                                     |         |                                                             |     |                                                                           |
| 10b     | Count host events if <a href="#">MSRC000_0080</a> [SVME]=1.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |      |             |     |                                                                                                                                                      |         |                                                                                                                                                                                                                                                                                                                                     |         |                                                             |     |                                                                           |
| 11b     | Count all guest and host events if <a href="#">MSRC000_0080</a> [SVME]=1.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |      |             |     |                                                                                                                                                      |         |                                                                                                                                                                                                                                                                                                                                     |         |                                                             |     |                                                                           |
| 39:36   | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |      |             |     |                                                                                                                                                      |         |                                                                                                                                                                                                                                                                                                                                     |         |                                                             |     |                                                                           |
| 35:32   | <b>EventSelect[11:8]: performance event select.</b> See: EventSelect[7:0].                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |      |             |     |                                                                                                                                                      |         |                                                                                                                                                                                                                                                                                                                                     |         |                                                             |     |                                                                           |
| 31:24   | <b>CntMask: counter mask.</b> Read-write. Controls the number of events counted per clock cycle.<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00h</td><td>The corresponding PERF_CTR[5:0] register increments by the number of events occurring in a clock cycle. Maximum number of events in one cycle is 32.</td></tr> <tr> <td>7Fh-01h</td><td>When Inv = 0, the corresponding PERF_CTR[5:0] register increments by 1, if the number of events occurring in a clock cycle is greater than or equal to the CntMask value.<br/>When Inv = 1, the corresponding PERF_CTR[5:0] register increments by 1, if the number of events occurring in a clock cycle is less than CntMask value.</td></tr> <tr> <td>FFh-80h</td><td>Reserved</td></tr> </table> | Bits | Description | 00h | The corresponding PERF_CTR[5:0] register increments by the number of events occurring in a clock cycle. Maximum number of events in one cycle is 32. | 7Fh-01h | When Inv = 0, the corresponding PERF_CTR[5:0] register increments by 1, if the number of events occurring in a clock cycle is greater than or equal to the CntMask value.<br>When Inv = 1, the corresponding PERF_CTR[5:0] register increments by 1, if the number of events occurring in a clock cycle is less than CntMask value. | FFh-80h | Reserved                                                    |     |                                                                           |
| Bits    | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |      |             |     |                                                                                                                                                      |         |                                                                                                                                                                                                                                                                                                                                     |         |                                                             |     |                                                                           |
| 00h     | The corresponding PERF_CTR[5:0] register increments by the number of events occurring in a clock cycle. Maximum number of events in one cycle is 32.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |      |             |     |                                                                                                                                                      |         |                                                                                                                                                                                                                                                                                                                                     |         |                                                             |     |                                                                           |
| 7Fh-01h | When Inv = 0, the corresponding PERF_CTR[5:0] register increments by 1, if the number of events occurring in a clock cycle is greater than or equal to the CntMask value.<br>When Inv = 1, the corresponding PERF_CTR[5:0] register increments by 1, if the number of events occurring in a clock cycle is less than CntMask value.                                                                                                                                                                                                                                                                                                                                                                                                                                      |      |             |     |                                                                                                                                                      |         |                                                                                                                                                                                                                                                                                                                                     |         |                                                             |     |                                                                           |
| FFh-80h | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |      |             |     |                                                                                                                                                      |         |                                                                                                                                                                                                                                                                                                                                     |         |                                                             |     |                                                                           |
| 23      | <b>Inv: invert counter mask.</b> Read-write. See CntMask.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |      |             |     |                                                                                                                                                      |         |                                                                                                                                                                                                                                                                                                                                     |         |                                                             |     |                                                                           |
| 22      | <b>En: enable performance counter.</b> Read-write. 1= Performance event counter is enabled.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |      |             |     |                                                                                                                                                      |         |                                                                                                                                                                                                                                                                                                                                     |         |                                                             |     |                                                                           |
| 21      | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |      |             |     |                                                                                                                                                      |         |                                                                                                                                                                                                                                                                                                                                     |         |                                                             |     |                                                                           |
| 20      | <b>Int: enable APIC interrupt.</b> Read-write. 1=APIC performance counter LVT interrupt is enabled to generate an interrupt via <a href="#">APIC340</a> [ <a href="#">LVT Performance Monitor</a> ] when the performance counter overflows.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |      |             |     |                                                                                                                                                      |         |                                                                                                                                                                                                                                                                                                                                     |         |                                                             |     |                                                                           |
| 19      | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |      |             |     |                                                                                                                                                      |         |                                                                                                                                                                                                                                                                                                                                     |         |                                                             |     |                                                                           |
| 18      | <b>Edge: edge detect.</b> Read-write. 0=Level detect. 1=Edge detect. The edge count mode increments the counter when a transition happens on the monitored event. If the event selected is changed without disabling the counter, an extra edge is falsely detected when the first event is a static 0 and the second event is a static one. To avoid this false edge detection, disable the counter when changing the event and then enable the counter with a second MSR write.                                                                                                                                                                                                                                                                                        |      |             |     |                                                                                                                                                      |         |                                                                                                                                                                                                                                                                                                                                     |         |                                                             |     |                                                                           |
| 17:16   | <b>OsUserMode: OS and user mode.</b> Read-write.<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>Count no events.</td></tr> <tr> <td>01b</td><td>Count user events (CPL&gt;0).</td></tr> <tr> <td>10b</td><td>Count OS events (CPL=0).</td></tr> <tr> <td>11b</td><td>Count all events, irrespective of the CPL.</td></tr> </table>                                                                                                                                                                                                                                                                                                                                                                                                          | Bits | Description | 00b | Count no events.                                                                                                                                     | 01b     | Count user events (CPL>0).                                                                                                                                                                                                                                                                                                          | 10b     | Count OS events (CPL=0).                                    | 11b | Count all events, irrespective of the CPL.                                |
| Bits    | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |      |             |     |                                                                                                                                                      |         |                                                                                                                                                                                                                                                                                                                                     |         |                                                             |     |                                                                           |
| 00b     | Count no events.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |      |             |     |                                                                                                                                                      |         |                                                                                                                                                                                                                                                                                                                                     |         |                                                             |     |                                                                           |
| 01b     | Count user events (CPL>0).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |      |             |     |                                                                                                                                                      |         |                                                                                                                                                                                                                                                                                                                                     |         |                                                             |     |                                                                           |
| 10b     | Count OS events (CPL=0).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |      |             |     |                                                                                                                                                      |         |                                                                                                                                                                                                                                                                                                                                     |         |                                                             |     |                                                                           |
| 11b     | Count all events, irrespective of the CPL.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |      |             |     |                                                                                                                                                      |         |                                                                                                                                                                                                                                                                                                                                     |         |                                                             |     |                                                                           |



|      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 15:8 | <b>UnitMask: event qualification.</b> Read-write. Each UnitMask bit further specifies or qualifies the event specified by EventSelect. All events selected by UnitMask are simultaneously monitored. Unless otherwise stated, the UnitMask values shown may be combined (logically ORed) to select any desired combination of the sub-events for a given event. In some cases, certain combinations can result in misleading counts, or the UnitMask value is an ordinal rather than a bit mask. These situations are described where applicable, or should be obvious from the event descriptions. For events where no UnitMask table is shown, the UnitMask is <b>Unused</b> . |
| 7:0  | <b>EventSelect[7:0]: event select.</b> Read-write. EventSelect[11:0] = {EventSelect[11:8], EventSelect[7:0]}. EventSelect specifies the event or event duration in a processor unit to be counted by the corresponding PERF_CTR[5:0] register. The events are specified in <a href="#">3.23 [Core Performance Counter Events]</a> . Some events are reserved; when a reserved event is selected, the results are undefined.                                                                                                                                                                                                                                                      |

### MSRC001\_020[B,9,7,5,3,1] Performance Event Counter (PERF\_CTR[5:0])

See [MSRC001\\_020\[A,8,6,4,2,0\] \[Performance Event Select \(PERF\\_CTL\[5:0\]\)\]](#). MSRC001\_00[07:04] is an alias of MSRC001\_020[7,5,3,1].

Table 252: [Register Mapping](#) for MSRC001\_020[B,9,7,5,3,1]

| Register     | Function  |
|--------------|-----------|
| MSRC001_0201 | Counter 0 |
| MSRC001_0203 | Counter 1 |
| MSRC001_0205 | Counter 2 |
| MSRC001_0207 | Counter 3 |
| MSRC001_0209 | Counter 4 |
| MSRC001_020B | Counter 5 |

| Bits  | Description                                                  |
|-------|--------------------------------------------------------------|
| 63:48 | RAZ.                                                         |
| 47:0  | <b>CTR: performance counter value.</b> Read-write. Reset: 0. |

### MSRC001\_024[6,4,2,0] Northbridge Performance Event Select (NB\_PERF\_CTL[3:0])

Per-node. See [2.6.1 \[Performance Monitor Counters\]](#). MSRC001\_024[6,4,2,0][31:0] is an alias of [D18F5x\[70,60,50,40\]](#). MSRC001\_024[6,4,2,0][63:32] is an alias of [D18F5x\[74,64,54,44\]](#).

Table 253: [Register Mapping](#) for MSRC001\_024[6,4,2,0]

| Register     | Function  |
|--------------|-----------|
| MSRC001_0240 | Counter 0 |
| MSRC001_0242 | Counter 1 |
| MSRC001_0244 | Counter 2 |
| MSRC001_0246 | Counter 3 |

Note: To get meaningful data, each of the counters should be similarly programmed across events selected.

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 63:36 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 35:32 | <b>EventSelect[11:8]: performance event select.</b> Read-write. Reset: 0. See EventSelect[7:0].                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 31:23 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 22    | <b>En: enable performance counter.</b> Read-write. Reset: 0. 1= Performance event counter is enabled.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 21    | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 20    | <b>Int: enable APIC interrupt.</b> Read-write. Reset: 0. 1=APIC performance counter LVT interrupt is enabled to generate an interrupt via <a href="#">APIC340 [LVT Performance Monitor]</a> to all local APIC's on this node when the performance counter overflows.                                                                                                                                                                                                                                                                                                                                                                                                                                |
| 19    | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 18:16 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 15:8  | <b>UnitMask: event qualification.</b> Read-write. Reset: 0. Each UnitMask bit further specifies or qualifies the event specified by EventSelect. All events selected by UnitMask are simultaneously monitored. Unless otherwise stated, the UnitMask values shown may be combined (logically ORed) to select any desired combination of the sub-events for a given event. In some cases, certain combinations can result in misleading counts, or the UnitMask value is an ordinal rather than a bit mask. These situations are described where applicable, or should be obvious from the event descriptions. For events where no UnitMask table is shown, the UnitMask is <a href="#">Unused</a> . |
| 7:0   | <b>EventSelect[7:0]: event select.</b> Read-write. Reset: 0. This field, along with EventSelect[11:8] above, combine to form the 12-bit event select field, EventSelect[11:0]. EventSelect specifies the event or event duration in a processor unit to be counted by the corresponding NB_PERF_CTR[3:0] register. The events are specified in <a href="#">3.24 [NB Performance Counter Events]</a> . Some events are reserved; when a reserved event is selected, the results are undefined.                                                                                                                                                                                                       |

### MSRC001\_024[7,5,3,1] Northbridge Performance Event Counter (NB\_PERF\_CTR[3:0])

Per-node. See [MSRC001\\_024\[6,4,2,0\] \[Northbridge Performance Event Select \(NB\\_PERF\\_CTL\[3:0\]\)\]](#). [MSRC001\\_024\[7,5,3,1\]\[31:0\]](#) is an alias of [D18F5x\[78,68,58,48\]](#). [MSRC001\\_024\[7,5,3,1\]\[63:32\]](#) is an alias of [D18F5x\[7C,6C,5C,4C\]](#).

Table 254: [Register Mapping](#) for [MSRC001\\_024\[7,5,3,1\]](#)

| Register     | Function  |
|--------------|-----------|
| MSRC001_0241 | Counter 0 |
| MSRC001_0243 | Counter 1 |
| MSRC001_0245 | Counter 2 |
| MSRC001_0247 | Counter 3 |

| Bits  | Description                                                                                                                                                   |
|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 63:48 | RAZ.                                                                                                                                                          |
| 47:32 | <b>CTR[47:32]: performance counter value[47:32].</b> See: CTR[31:0].                                                                                          |
| 31:0  | <b>CTR[31:0]: performance counter value[31:0].</b> Read-write. Reset: 0. CTR[47:0] = {CTR[47:32], CTR[31:0]}. Returns the current value of the event counter. |

**MSRC001\_0280 Performance Time Stamp Counter (CU\_PTSC)**

Support for [MSRC001\\_0280 \[Performance Time Stamp Counter \(CU\\_PTSC\)\]](#) indicated by [CPUID Fn8000\\_0001\\_ECX](#)[PerfTsc]. The size of PTSC indicated by [CPUID Fn8000\\_0008\\_ECX](#)[PerfTscSize]. Increments at a 100 MHz rate in all P-states, all C states, S0, or S1. Each core on a node at the same instant in time will vary by +/- 3 100 MHz clocks. The value of PTSC[31:0] will be inserted into each record produced.

| Bits  | Description                                                                      |
|-------|----------------------------------------------------------------------------------|
| 63:40 | RAZ.                                                                             |
| 39:0  | <b>PTSC: global timestamp counter.</b> Read-only; updated-by-hardware. Reset: 0. |

### 3.22 MSRs - MSRC001\_1xxx

#### MSRC001\_1002 CPUID Features for CPUID Fn0000\_0007\_E[B,A]X\_x0

Read-write. Reset: {CPUID Fn0000\_0007\_EAX\_x0, CPUID Fn0000\_0007\_EBX\_x0}.

MSRC001\_1002[63:32] provides back-door control over values read from CPUID Fn0000\_0007\_EAX\_x0;

MSRC001\_1002[31:0] provides back-door control over values read from CPUID Fn0000\_0007\_EBX\_x0.

| Bits | Description  |
|------|--------------|
| 63:9 | Reserved.    |
| 8    | Reserved.    |
| 7    | Reserved.    |
| 6    | Reserved.    |
| 5    | Reserved.    |
| 4    | Reserved.    |
| 3    | <b>BMH1.</b> |
| 2:1  | Reserved.    |
| 0    | Reserved.    |

#### MSRC001\_1003 Thermal and Power Management CPUID Features

MSRC001\_1003 provides control over values read from CPUID Fn0000\_0006\_ECX.

| Bits  | Description                                                                                                                                   |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------|
| 63:32 | Reserved.                                                                                                                                     |
| 31:0  | <b>FeaturesEcX.</b> Read-write. Reset: CPUID Fn0000_0006_ECX. Provides back-door control over the features reported in CPUID Fn0000_0006_ECX. |

#### MSRC001\_1004 CPUID Features (Features)

Read-write. Reset: {CPUID Fn0000\_0001\_ECX, CPUID Fn0000\_0001\_EDX}. MSRC001\_1004[63:32] provides back-door control over values read from CPUID Fn0000\_0001\_ECX; MSRC001\_1004[31:0] provides

back-door control over values read from [CPUID Fn0000\\_0001\\_EDX](#).

| Bits  | Description                                                                                                                        |
|-------|------------------------------------------------------------------------------------------------------------------------------------|
| 63    | Reserved.                                                                                                                          |
| 62    | <b>RDRAND.</b>                                                                                                                     |
| 61    | <b>F16C.</b>                                                                                                                       |
| 60    | <b>AVX.</b>                                                                                                                        |
| 59    | <b>OSXSAVE.</b> Modifies <a href="#">CPUID Fn0000_0001_ECX[OSXSAVE]</a> only if CR4[OSXSAVE].                                      |
| 58    | <b>XSAVE.</b>                                                                                                                      |
| 57    | <b>AES.</b> Modifies <a href="#">CPUID Fn0000_0001_ECX[AES]</a> only if the reset value is 1 .                                     |
| 56    | Reserved.                                                                                                                          |
| 55    | <b>POPCNT.</b>                                                                                                                     |
| 54    | Reserved.                                                                                                                          |
| 53    | <b>x2APIC.</b>                                                                                                                     |
| 52    | <b>SSE42.</b>                                                                                                                      |
| 51    | <b>SSE41.</b>                                                                                                                      |
| 50:46 | Reserved.                                                                                                                          |
| 45    | <b>CMPXCHG16B.</b>                                                                                                                 |
| 44:42 | Reserved.                                                                                                                          |
| 41    | <b>SSSE3.</b>                                                                                                                      |
| 40:36 | Reserved.                                                                                                                          |
| 35    | <b>Monitor.</b> Modifies <a href="#">CPUID Fn0000_0001_ECX[Monitor]</a> only if $\sim$ <a href="#">MSRC001_0015[MonMwaitDis]</a> . |
| 34    | Reserved.                                                                                                                          |
| 33    | <b>PCLMULQDQ.</b> Modifies <a href="#">CPUID Fn0000_0001_ECX[PCLMULQDQ]</a> only if the reset value is 1                           |
| 32    | <b>SSE3.</b>                                                                                                                       |
| 31:29 | Reserved.                                                                                                                          |
| 28    | <b>HTT.</b>                                                                                                                        |
| 27    | Reserved.                                                                                                                          |
| 26    | <b>SSE2.</b>                                                                                                                       |
| 25    | <b>SSE.</b>                                                                                                                        |
| 24    | <b>FXSR.</b>                                                                                                                       |
| 23    | <b>MMX.</b>                                                                                                                        |
| 22:20 | Reserved.                                                                                                                          |
| 19    | <b>CLFSH.</b>                                                                                                                      |
| 18    | Reserved.                                                                                                                          |
| 17    | <b>PSE36.</b>                                                                                                                      |
| 16    | <b>PAT.</b>                                                                                                                        |
| 15    | <b>CMOV.</b>                                                                                                                       |
| 14    | <b>MCA.</b>                                                                                                                        |

|    |                                                                                                                   |
|----|-------------------------------------------------------------------------------------------------------------------|
| 13 | <b>PGE.</b>                                                                                                       |
| 12 | <b>MTRR.</b>                                                                                                      |
| 11 | <b>SysEnterSysExit.</b>                                                                                           |
| 10 | Reserved.                                                                                                         |
| 9  | <b>APIC.</b> Modifies <a href="#">CPUID Fn0000_0001_EDX</a> [APIC] only if <a href="#">MSR0000_001B</a> [ApicEn]. |
| 8  | <b>CMPXCHG8B.</b>                                                                                                 |
| 7  | <b>MCE.</b>                                                                                                       |
| 6  | <b>PAE.</b>                                                                                                       |
| 5  | <b>MSR.</b>                                                                                                       |
| 4  | <b>TSC.</b>                                                                                                       |
| 3  | <b>PSE.</b>                                                                                                       |
| 2  | <b>DE.</b>                                                                                                        |
| 1  | <b>VME.</b>                                                                                                       |
| 0  | <b>FPU.</b>                                                                                                       |

#### **MSRC001\_1005 Extended CPUID Features (ExtFeatures)**

Read-write. Reset: {[CPUID Fn8000\\_0001\\_ECX](#), [CPUID Fn8000\\_0001\\_EDX](#)}. [MSRC001\\_1005](#)[63:32] provides back-door control over values read from [CPUID Fn8000\\_0001\\_ECX](#); [MSRC001\\_1005](#)[31:0] provides back-door control over values read from [CPUID Fn8000\\_0001\\_EDX](#).

| Bits  | Description                                                                                                        |
|-------|--------------------------------------------------------------------------------------------------------------------|
| 63:61 | Reserved.                                                                                                          |
| 60    | <b>PerfCtrExtL2I.</b>                                                                                              |
| 59    | <b>PerfTsc.</b>                                                                                                    |
| 58    | <b>DataBreakpointExtension.</b>                                                                                    |
| 57    | Reserved.                                                                                                          |
| 56    | <b>PerfCtrExtNB.</b>                                                                                               |
| 55    | <b>PerfCtrExtCore.</b>                                                                                             |
| 54    | <b>TopologyExtensions.</b> BIOS: IF ( <a href="#">CPUID Fn8000_0001_EBX</a> [PkgType]==0001b) THEN 1 ELSE 0 ENDIF. |
| 53    | <b>TBM.</b>                                                                                                        |
| 52    | Reserved.                                                                                                          |
| 51    | <b>NodeId.</b><br>BIOS: 1.                                                                                         |
| 50    | Reserved.                                                                                                          |
| 49    | Reserved.                                                                                                          |
| 48    | <b>FMA4.</b>                                                                                                       |
| 47    | <b>LWP.</b>                                                                                                        |
| 46    | Reserved.                                                                                                          |

|       |                                                                                                                |
|-------|----------------------------------------------------------------------------------------------------------------|
| 45    | <b>WDT.</b>                                                                                                    |
| 44    | <b>SKINIT.</b>                                                                                                 |
| 43    | <b>XOP.</b>                                                                                                    |
| 42    | <b>IBS.</b>                                                                                                    |
| 41    | <b>OSVW.</b>                                                                                                   |
| 40    | <b>3DNowPrefetch.</b>                                                                                          |
| 39    | <b>MisAlignSse.</b>                                                                                            |
| 38    | <b>SSE4A.</b>                                                                                                  |
| 37    | <b>ABM.</b>                                                                                                    |
| 36    | <b>AltMovCr8.</b>                                                                                              |
| 35    | <b>ExtApicSpace.</b>                                                                                           |
| 34    | <b>SVM.</b> Modifies <a href="#">CPUID Fn8000_0001_ECX[SVM]</a> only if <a href="#">D18F3xE8[SvmCapable]</a> . |
| 33    | <b>CmpLegacy.</b>                                                                                              |
| 32    | <b>LahfSahf.</b>                                                                                               |
| 31    | <b>3DNow.</b>                                                                                                  |
| 30    | <b>3DNowExt.</b>                                                                                               |
| 29    | <b>LM.</b> Read-write.                                                                                         |
| 28    | Reserved.                                                                                                      |
| 27    | <b>RDTSCP.</b>                                                                                                 |
| 26    | <b>Page1GB.</b>                                                                                                |
| 25    | <b>FFXSR.</b>                                                                                                  |
| 24    | <b>FXSR.</b>                                                                                                   |
| 23    | <b>MMX.</b>                                                                                                    |
| 22    | <b>MmxExt.</b>                                                                                                 |
| 21    | Reserved.                                                                                                      |
| 20    | <b>NX.</b>                                                                                                     |
| 19:18 | Reserved.                                                                                                      |
| 17    | <b>PSE36.</b>                                                                                                  |
| 16    | <b>PAT.</b>                                                                                                    |
| 15    | <b>CMOV.</b>                                                                                                   |
| 14    | <b>MCA.</b>                                                                                                    |
| 13    | <b>PGE.</b>                                                                                                    |
| 12    | <b>MTRR.</b>                                                                                                   |
| 11    | <b>SysCallSysRet.</b>                                                                                          |
| 10    | Reserved.                                                                                                      |
| 9     | <b>APIC.</b>                                                                                                   |
| 8     | <b>CMPXCHG8B.</b>                                                                                              |

|   |             |
|---|-------------|
| 7 | <b>MCE.</b> |
| 6 | <b>PAE.</b> |
| 5 | <b>MSR.</b> |
| 4 | <b>TSC.</b> |
| 3 | <b>PSE.</b> |
| 2 | <b>DE.</b>  |
| 1 | <b>VME.</b> |
| 0 | <b>FPU.</b> |

### MSRC001\_101[B:9] Address Mask For DR[3:1] Breakpoints

Reset: 0000\_0000\_0000\_0000h. Support indicated by [CPUID Fn8000\\_0001\\_ECX\[DataBreakpointExtension\]](#). See [MSRC001\\_1027](#).

Table 255: [Register Mapping](#) for MSRC001\_101[B:9]

| Register     | Function      |
|--------------|---------------|
| MSRC001_1019 | DR1_ADDR_MASK |
| MSRC001_101A | DR2_ADDR_MASK |
| MSRC001_101B | DR3_ADDR_MASK |

Table 256: [Field Mapping](#) for MSRC001\_101[B:9]

| Register     | Bits |
|--------------|------|
|              | 31:0 |
| MSRC001_1019 | DR1  |
| MSRC001_101A | DR2  |
| MSRC001_101B | DR3  |

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 63:32 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 31:0  | <b>AddrMask: mask for DR linear address data breakpoint.</b> Read-write. This field qualifies the DR linear address data breakpoint, allowing the DR[3:1] data breakpoint on a range of addresses in memory. The mask bits are active high; 0=Include bit into address compare; 1=Exclude bit into address compare. AddrMask is always used, and it can be used in conjunction with any debug function that uses DR[3:1]. The legacy DR breakpoint function is provided by AddrMask[31:0]==0000_0000h). |

### MSRC001\_1020 Load-Store Configuration (LS\_CFG)

| Bits  | Description |
|-------|-------------|
| 63:29 | Reserved.   |



|      |                                                                                                                                                                                       |
|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 28   | <b>DisSS</b> . Read-write; <b>Same-for-all</b> . Reset: 0. BIOS: See <a href="#">2.3.3 [Using L2 Cache as General Storage During Boot]</a> . 1=Disable streaming store functionality. |
| 27:0 | Reserved.                                                                                                                                                                             |

### MSRC001\_1021 Instruction Cache Configuration (IC\_CFG)

Per-compute-unit.

| Bits  | Description                                                                                                                                                                                                                                               |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 63:10 | Reserved.                                                                                                                                                                                                                                                 |
| 9     | <b>DisSpecTlbRld</b> . Read-write. Reset: 0. 1=Disable speculative IC TLB reload request; the request is not made to the TLB walker until the fetch is non-speculative. BIOS: See <a href="#">2.3.3 [Using L2 Cache as General Storage During Boot]</a> . |
| 8:0   | Reserved.                                                                                                                                                                                                                                                 |

### MSRC001\_1022 Data Cache Configuration (DC\_CFG)

| Bits  | Description                                                                                                                                                       |
|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 63:16 | Reserved.                                                                                                                                                         |
| 15    | <b>DisPFHwForSw</b> . Read-write. Reset: 0. 1=Disable hardware prefetches for software prefetches.                                                                |
| 14    | Reserved.                                                                                                                                                         |
| 13    | <b>DisHwPf</b> . Read-write. Reset: 0. 1=Disable the DC hardware prefetcher. BIOS: See <a href="#">2.3.3 [Using L2 Cache as General Storage During Boot]</a> .    |
| 12:5  | Reserved.                                                                                                                                                         |
| 4     | <b>DisSpecTlbRld</b> . Read-write. Reset: 0. 1=Disable speculative TLB reloads. BIOS: See <a href="#">2.3.3 [Using L2 Cache as General Storage During Boot]</a> . |
| 3:0   | Reserved.                                                                                                                                                         |

### MSRC001\_1023 Combined Unit Configuration (CU\_CFG)

Per-compute-unit.

| Bits  | Description                                                                                                                                                                                                                                                            |
|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 63:52 | Reserved.                                                                                                                                                                                                                                                              |
| 51    | Reserved.                                                                                                                                                                                                                                                              |
| 50    | Reserved.                                                                                                                                                                                                                                                              |
| 49    | <b>ProcFeedbackEn: processor feedback interface enable</b> . Read-write. Reset: 0. BIOS: 1. 1=Enable processor feedback interface; <a href="#">CPUID Fn8000_0007_EAX</a> .                                                                                             |
| 48:35 | Reserved.                                                                                                                                                                                                                                                              |
| 34    | <b>WbinvdFlushClean</b> . Read-write. Reset: 0. BIOS: 1. 1=Flush all L2 lines on CC6 entry in microcode loop, including clean lines. 0=Flush only dirty lines on CC6 entry in microcode loop, leaving L2 clean line invalidation to the CU invalidation state machine. |

| 33:24 | Reserved.                                                                                                                                                                                                                                                                                                                                            |      |             |    |          |       |                                       |    |                |
|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|----|----------|-------|---------------------------------------|----|----------------|
| 23    | <b>L2WayLock: L2 way lock enable.</b> Read-write. Reset: 0. 1=Allocations and evictions for the L2 ways >= L2FirstLockedWay are disabled. Probes can still invalidate a line in a locked way. Cache lines in the locked ways of the L2 are still accessible by software. See <a href="#">2.3.3 [Using L2 Cache as General Storage During Boot]</a> . |      |             |    |          |       |                                       |    |                |
| 22:19 | <b>L2FirstLockedWay: first L2 way locked.</b> Read-write. Reset: 0h. See L2WayLock.<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>0h</td><td>Reserved</td></tr> <tr> <td>Eh-1h</td><td>Ways &lt;L2FirstLockedWay&gt; to 15 locked.</td></tr> <tr> <td>Fh</td><td>Way 15 locked.</td></tr> </table>                                 | Bits | Description | 0h | Reserved | Eh-1h | Ways <L2FirstLockedWay> to 15 locked. | Fh | Way 15 locked. |
| Bits  | Description                                                                                                                                                                                                                                                                                                                                          |      |             |    |          |       |                                       |    |                |
| 0h    | Reserved                                                                                                                                                                                                                                                                                                                                             |      |             |    |          |       |                                       |    |                |
| Eh-1h | Ways <L2FirstLockedWay> to 15 locked.                                                                                                                                                                                                                                                                                                                |      |             |    |          |       |                                       |    |                |
| Fh    | Way 15 locked.                                                                                                                                                                                                                                                                                                                                       |      |             |    |          |       |                                       |    |                |
| 18:0  | Reserved.                                                                                                                                                                                                                                                                                                                                            |      |             |    |          |       |                                       |    |                |

### MSRC001\_1027 Address Mask For DR0 Breakpoints (DR0\_ADDR\_MASK)

Reset: 0000\_0000\_0000\_0000h. Support for AddrMaskDR0[31:12] is indicated by [CUID Fn8000\\_0001\\_ECX\[DataBreakpointExtension\]](#). See [MSRC001\\_101\[B:9\]](#).

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 63:32 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 31:0  | <b>AddrMaskDR0: mask for DR0 linear address data breakpoint.</b> Read-write. This field qualifies the DR0 linear address data breakpoint, allowing the DR0 data breakpoint on a range of addresses in memory. The mask bits are active high; 0=Include bit into address compare; 1=Exclude bit into address compare. AddrMaskDR0 is always used, and it can be used in conjunction with any debug function that uses DR0. AddrMaskDR0[31:12] is only valid for data breakpoints. The legacy DR0 breakpoint function is provided by AddrMaskDR0[31:0]==0000_0000h). |

### MSRC001\_1028 Floating Point Configuration (FP\_CFG)

[Per-compute-unit.](#)

| Bits  | Description                                                                                   |
|-------|-----------------------------------------------------------------------------------------------|
| 63:45 | Reserved.                                                                                     |
| 44:41 | <b>DiDtCfg4.</b> Read-write. Reset: 1111b.<br>BIOS: <a href="#">D18F3x1FC[DiDtCfg4]</a> .     |
| 40    | <b>DiDtCfg3.</b> Read-write. Reset: 0. BIOS: <a href="#">D18F3x1FC[DiDtCfg3]</a> .            |
| 39:35 | Reserved.                                                                                     |
| 34:27 | <b>DiDtCfg1.</b> Read-write. Reset: 10011011b.<br>BIOS: <a href="#">D18F3x1FC[DiDtCfg1]</a> . |
| 26:25 | <b>DiDtCfg2.</b> Read-write. Reset: 00b.<br>BIOS: <a href="#">D18F3x1FC[DiDtCfg2]</a> .       |
| 24:23 | Reserved.                                                                                     |

|       |                                                                                    |
|-------|------------------------------------------------------------------------------------|
| 22:18 | <b>DiDtCfg0</b> . Read-write. Reset: 11111b.<br>BIOS: <b>D18F3x1FC</b> [DiDtCfg0]. |
| 17    | Reserved.                                                                          |
| 16    | <b>DiDtMode</b> . Read-write. Reset: 0.<br>BIOS: <b>D18F3x1FC</b> [DiDtMode].      |
| 15:0  | Reserved.                                                                          |

### MSRC001\_102A Combined Unit Configuration 2 (CU\_CFG2)

#### Per-compute-unit.

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 63:57 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 56:52 | <b>L2UpsizeCUCT: L2 upsize detector Committed Micro-op Counter Threshold</b> . Read-write. Reset: 0. BIOS: 1Fh.                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 51    | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 50    | <b>RdMmExtCfgQwEn: read mmio extended config quadword enable</b> . Read-write. Reset: 0. BIOS: 1. 1=MMIO reads to extended config space do not need to be doubleword aligned and may be up to quadword sized. This is to support 64-bit MMIO reads to extended config space. 0=MMIO reads to extended config space need to be doubleword aligned and may be up to doubleword sized. MMIO reads to extended config space that are either not doubleword aligned or greater than doubleword sized are treated as plain MMIO reads. |
| 49:38 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 37:36 | <b>ThrottleNbInterface[3:2]</b> . Read-write. Reset: 01b. BIOS: 00b. See ThrottleNbInterface[1:0].                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 35:26 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 25    | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 24    | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 23:22 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 21:18 | <b>L2UpsizeCSWT[4:1]: L2 upsize context switch warmup threshold [4:1]</b> . Read-write. Reset: 0. BIOS: 0000b. See L2UpsizeCSWT[0].                                                                                                                                                                                                                                                                                                                                                                                              |
| 17:15 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 14    | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 13:11 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 10    | <b>VicResyncChkEn</b> . Read-write. Reset: 0. BIOS: 1. 1=Generate an internal probe to NB for non-shared victims. Required to be set for the Monitor/MWait instructions.                                                                                                                                                                                                                                                                                                                                                         |

| 9     | <b>L2UpsizeCSWT[0]: L2 upsize context switch warmup threshold [0]</b> . Read-write. Reset: 0. BIOS: 0b. L2UpsizeCSWT[4:0] = {L2UpsizeCSWT[4:1], L2UpsizeCSWT[0]}.<br>The L2UpsizeCSWT defines the context switch warmup threshold for L2 cache upsize. When non-zero, both the internal eviction count and the internal committed uop count are cleared when either a context switch occurs (indicated by MOV CR3) or the committed uop count exceeds the L2UpsizeCSWT[4:0]*8K following a context switch. This defines a period where many rapid evictions can occur without causing an L2 cache upsize following a context switch.                                                                                                                                                                                                             |      |             |    |           |    |          |    |           |    |           |       |           |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|----|-----------|----|----------|----|-----------|----|-----------|-------|-----------|
| 8     | <b>SpecNbReqDis</b> . Read-write. Reset: 0. 1=Disables speculative NB requests.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |      |             |    |           |    |          |    |           |    |           |       |           |
| 7:6   | <b>ThrottleNbInterface[1:0]</b> . Read-write. ThrottleNbInterface[3:0] = {ThrottleNbInterface[3:2], ThrottleNbInterface[1:0]}. Reset: 11b. BIOS: NumOfCompUnits-1. Specifies how many clocks the CU needs to wait before sending the next packet of information to the NB. This applies to the CU->NB request interface and the CU->NB probe response interface.<br>This field must be programmed to a value greater than or equal to the number of compute units in the node that have at least one enabled core minus 1. See 2.4.4 [Processor Cores and Downcoring].<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>0h</td><td>0 Clocks.</td></tr> <tr> <td>1h</td><td>1 Clock.</td></tr> <tr> <td>2h</td><td>2 Clocks.</td></tr> <tr> <td>3h</td><td>3 Clocks.</td></tr> <tr> <td>Fh-4h</td><td>Reserved.</td></tr> </table> | Bits | Description | 0h | 0 Clocks. | 1h | 1 Clock. | 2h | 2 Clocks. | 3h | 3 Clocks. | Fh-4h | Reserved. |
| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |      |             |    |           |    |          |    |           |    |           |       |           |
| 0h    | 0 Clocks.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |      |             |    |           |    |          |    |           |    |           |       |           |
| 1h    | 1 Clock.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |      |             |    |           |    |          |    |           |    |           |       |           |
| 2h    | 2 Clocks.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |      |             |    |           |    |          |    |           |    |           |       |           |
| 3h    | 3 Clocks.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |      |             |    |           |    |          |    |           |    |           |       |           |
| Fh-4h | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |      |             |    |           |    |          |    |           |    |           |       |           |
| 5     | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |      |             |    |           |    |          |    |           |    |           |       |           |
| 4:0   | <b>L2UpsizeERT: L2 upsize evict rate threshold</b> . Read-write. Reset: 0. BIOS: 01101b.<br>The L2UpsizeERT defines the eviction rate threshold that can cause an L2 cache upsize after a CC6 exit. When L2UpsizeERT is zero, the L2 cache upsize mechanism is disabled. When L2UpsizeERT is non-zero, L2 cache upsizes can be triggered after the internal committed uop counter interval expires (defined by L2UpsizeCUCT) if the internal eviction counter equals or exceeds the L2UpsizeERT[4:0]*64. Ratios of the L2UpsizeERT and L2UpsizeCUCT support a range of 0.00024 through 0.25 evictions per committed uop for L2 cache upsize tuning.                                                                                                                                                                                              |      |             |    |           |    |          |    |           |    |           |       |           |

### MSRC001\_102B Combined Unit Configuration 3 (CU\_CFG3)

#### Per-compute-unit.

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |      |             |     |                                                                         |     |                                                                          |     |                                                                          |     |                                                                          |
|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|-----|-------------------------------------------------------------------------|-----|--------------------------------------------------------------------------|-----|--------------------------------------------------------------------------|-----|--------------------------------------------------------------------------|
| 63:61 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |      |             |     |                                                                         |     |                                                                          |     |                                                                          |     |                                                                          |
| 60:59 | <b>PcidDecrScaleFactor</b> . Read-write. Reset: 00b. Specifies the decrement rate for the PCID replacement counter for PCIDs not currently in use; The larger the value programmed the slower the counter decrements.<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>Inactive PCID replacement counter decrements every 64 TLB replacements.</td></tr> <tr> <td>01b</td><td>Inactive PCID replacement counter decrements every 128 TLB replacements.</td></tr> <tr> <td>10b</td><td>Inactive PCID replacement counter decrements every 256 TLB replacements.</td></tr> <tr> <td>11b</td><td>Inactive PCID replacement counter decrements every 512 TLB replacements.</td></tr> </table> | Bits | Description | 00b | Inactive PCID replacement counter decrements every 64 TLB replacements. | 01b | Inactive PCID replacement counter decrements every 128 TLB replacements. | 10b | Inactive PCID replacement counter decrements every 256 TLB replacements. | 11b | Inactive PCID replacement counter decrements every 512 TLB replacements. |
| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |      |             |     |                                                                         |     |                                                                          |     |                                                                          |     |                                                                          |
| 00b   | Inactive PCID replacement counter decrements every 64 TLB replacements.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |      |             |     |                                                                         |     |                                                                          |     |                                                                          |     |                                                                          |
| 01b   | Inactive PCID replacement counter decrements every 128 TLB replacements.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |      |             |     |                                                                         |     |                                                                          |     |                                                                          |     |                                                                          |
| 10b   | Inactive PCID replacement counter decrements every 256 TLB replacements.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |      |             |     |                                                                         |     |                                                                          |     |                                                                          |     |                                                                          |
| 11b   | Inactive PCID replacement counter decrements every 512 TLB replacements.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |      |             |     |                                                                         |     |                                                                          |     |                                                                          |     |                                                                          |

| 58:57       | <p><b>PcidIncrScaleFactor.</b> Read-write. Reset: 00b. Specifies the increment rate for the PCID replacement counter for PCIDs currently in use; The larger the value programmed the slower the counter increments.</p> <table> <tr> <th><u>Bits</u></th><th><u>Description</u></th></tr> <tr> <td>00b</td><td>Active PCID replacement counter increments every 16 TLB inserts.</td></tr> <tr> <td>01b</td><td>Active PCID replacement counter increments every 32 TLB inserts.</td></tr> <tr> <td>10b</td><td>Active PCID replacement counter increments every 64 TLB inserts.</td></tr> <tr> <td>11b</td><td>Active PCID replacement counter increments every 128 TLB inserts.</td></tr> </table>                                   | <u>Bits</u> | <u>Description</u> | 00b | Active PCID replacement counter increments every 16 TLB inserts.        | 01b | Active PCID replacement counter increments every 32 TLB inserts.         | 10b | Active PCID replacement counter increments every 64 TLB inserts.         | 11b | Active PCID replacement counter increments every 128 TLB inserts.        |
|-------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|--------------------|-----|-------------------------------------------------------------------------|-----|--------------------------------------------------------------------------|-----|--------------------------------------------------------------------------|-----|--------------------------------------------------------------------------|
| <u>Bits</u> | <u>Description</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |             |                    |     |                                                                         |     |                                                                          |     |                                                                          |     |                                                                          |
| 00b         | Active PCID replacement counter increments every 16 TLB inserts.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |             |                    |     |                                                                         |     |                                                                          |     |                                                                          |     |                                                                          |
| 01b         | Active PCID replacement counter increments every 32 TLB inserts.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |             |                    |     |                                                                         |     |                                                                          |     |                                                                          |     |                                                                          |
| 10b         | Active PCID replacement counter increments every 64 TLB inserts.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |             |                    |     |                                                                         |     |                                                                          |     |                                                                          |     |                                                                          |
| 11b         | Active PCID replacement counter increments every 128 TLB inserts.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |             |                    |     |                                                                         |     |                                                                          |     |                                                                          |     |                                                                          |
| 56:55       | <p><b>AsidIncrScaleFactor.</b> Read-write. Reset: 00b. Specifies the increment rate for the ASID replacement counter for ASIDs currently in use; The larger the value programmed the slower the counter increments.</p> <table> <tr> <th><u>Bits</u></th><th><u>Description</u></th></tr> <tr> <td>00b</td><td>Active ASID replacement counter increments every 16 TLB inserts.</td></tr> <tr> <td>01b</td><td>Active ASID replacement counter increments every 32 TLB inserts.</td></tr> <tr> <td>10b</td><td>Active ASID replacement counter increments every 64 TLB inserts.</td></tr> <tr> <td>11b</td><td>Active ASID replacement counter increments every 128 TLB inserts.</td></tr> </table>                                   | <u>Bits</u> | <u>Description</u> | 00b | Active ASID replacement counter increments every 16 TLB inserts.        | 01b | Active ASID replacement counter increments every 32 TLB inserts.         | 10b | Active ASID replacement counter increments every 64 TLB inserts.         | 11b | Active ASID replacement counter increments every 128 TLB inserts.        |
| <u>Bits</u> | <u>Description</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |             |                    |     |                                                                         |     |                                                                          |     |                                                                          |     |                                                                          |
| 00b         | Active ASID replacement counter increments every 16 TLB inserts.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |             |                    |     |                                                                         |     |                                                                          |     |                                                                          |     |                                                                          |
| 01b         | Active ASID replacement counter increments every 32 TLB inserts.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |             |                    |     |                                                                         |     |                                                                          |     |                                                                          |     |                                                                          |
| 10b         | Active ASID replacement counter increments every 64 TLB inserts.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |             |                    |     |                                                                         |     |                                                                          |     |                                                                          |     |                                                                          |
| 11b         | Active ASID replacement counter increments every 128 TLB inserts.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |             |                    |     |                                                                         |     |                                                                          |     |                                                                          |     |                                                                          |
| 54:53       | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |             |                    |     |                                                                         |     |                                                                          |     |                                                                          |     |                                                                          |
| 52:51       | <p><b>AsidDecrScaleFactor.</b> Read-write. Reset: 00b. Specifies the decrement rate for the ASID replacement counter for ASIDs not currently in use; The larger the value programmed the slower the counter decrements.</p> <table> <tr> <th><u>Bits</u></th><th><u>Description</u></th></tr> <tr> <td>00b</td><td>Inactive ASID replacement counter decrements every 64 TLB replacements.</td></tr> <tr> <td>01b</td><td>Inactive ASID replacement counter decrements every 128 TLB replacements.</td></tr> <tr> <td>10b</td><td>Inactive ASID replacement counter decrements every 256 TLB replacements.</td></tr> <tr> <td>11b</td><td>Inactive ASID replacement counter decrements every 512 TLB replacements.</td></tr> </table> | <u>Bits</u> | <u>Description</u> | 00b | Inactive ASID replacement counter decrements every 64 TLB replacements. | 01b | Inactive ASID replacement counter decrements every 128 TLB replacements. | 10b | Inactive ASID replacement counter decrements every 256 TLB replacements. | 11b | Inactive ASID replacement counter decrements every 512 TLB replacements. |
| <u>Bits</u> | <u>Description</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |             |                    |     |                                                                         |     |                                                                          |     |                                                                          |     |                                                                          |
| 00b         | Inactive ASID replacement counter decrements every 64 TLB replacements.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |             |                    |     |                                                                         |     |                                                                          |     |                                                                          |     |                                                                          |
| 01b         | Inactive ASID replacement counter decrements every 128 TLB replacements.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |             |                    |     |                                                                         |     |                                                                          |     |                                                                          |     |                                                                          |
| 10b         | Inactive ASID replacement counter decrements every 256 TLB replacements.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |             |                    |     |                                                                         |     |                                                                          |     |                                                                          |     |                                                                          |
| 11b         | Inactive ASID replacement counter decrements every 512 TLB replacements.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |             |                    |     |                                                                         |     |                                                                          |     |                                                                          |     |                                                                          |
| 50          | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |             |                    |     |                                                                         |     |                                                                          |     |                                                                          |     |                                                                          |
| 49          | <p><b>CombineCr0Cd: combine CR0[CD] for both cores of a compute unit.</b> Read-write. Reset: 0. BIOS: 1. BIOS: Must not be set when using L2 cache as general storage during boot; See <a href="#">2.3.3 [Using L2 Cache as General Storage During Boot]</a>; Must be set before passing control to the OS.</p> <p>0=The effective-CR0[CD] is not affected by the hCR0[CD] on other cores.</p> <p>1=The effective CR0[CD], for all modes, is forced to 1 if the logical OR of the hCR0[CD] for all other cores on the compute unit is 1. Note that the logical OR does not include the local core hCR0[CD].</p>                                                                                                                       |             |                    |     |                                                                         |     |                                                                          |     |                                                                          |     |                                                                          |
| 48:43       | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |             |                    |     |                                                                         |     |                                                                          |     |                                                                          |     |                                                                          |
| 42          | <p><b>PwcDisableWalkerSharing.</b> Read-write. Reset: 0. BIOS: 0. 1=Page table walker sharing is disabled. Core 0 uses page walker 0 and Core 1 uses page walker 1.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |             |                    |     |                                                                         |     |                                                                          |     |                                                                          |     |                                                                          |
| 41:23       | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |             |                    |     |                                                                         |     |                                                                          |     |                                                                          |     |                                                                          |
| 22          | <p><b>PfcDoubleStride.</b> Read-write. Reset: 0. BIOS: 1. 1=Prefetch N and N+1 offsets ahead of a stride miss instead of just N. N is configurable by PfcStrideMul.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |             |                    |     |                                                                         |     |                                                                          |     |                                                                          |     |                                                                          |
| 21:20       | <p><b>PfcStrideMul.</b> Read-write. Reset: 01b. Specifies the number of stride offsets that are prefetched.</p> <table> <tr> <th><u>Bits</u></th><th><u>Description</u></th></tr> <tr> <td>00b</td><td>3</td></tr> <tr> <td>01b</td><td>4</td></tr> <tr> <td>10b</td><td>5</td></tr> <tr> <td>11b</td><td>6</td></tr> </table>                                                                                                                                                                                                                                                                                                                                                                                                        | <u>Bits</u> | <u>Description</u> | 00b | 3                                                                       | 01b | 4                                                                        | 10b | 5                                                                        | 11b | 6                                                                        |
| <u>Bits</u> | <u>Description</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |             |                    |     |                                                                         |     |                                                                          |     |                                                                          |     |                                                                          |
| 00b         | 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |             |                    |     |                                                                         |     |                                                                          |     |                                                                          |     |                                                                          |
| 01b         | 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |             |                    |     |                                                                         |     |                                                                          |     |                                                                          |     |                                                                          |
| 10b         | 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |             |                    |     |                                                                         |     |                                                                          |     |                                                                          |     |                                                                          |
| 11b         | 6                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |             |                    |     |                                                                         |     |                                                                          |     |                                                                          |     |                                                                          |
| 19          | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |             |                    |     |                                                                         |     |                                                                          |     |                                                                          |     |                                                                          |

|      |                                                                                                             |
|------|-------------------------------------------------------------------------------------------------------------|
| 18   | <b>PfcDis.</b> Read-write. Reset: 0. 1=Prefetcher disabled.                                                 |
| 17   | <b>PfcStrideDis.</b> Read-write. Reset: 0. 1=Stride prefetch generation disabled.                           |
| 16   | <b>PfcRegionDis.</b> Read-write. Reset: 0. 1=Region prefetch generation disabled.                           |
| 15:4 | Reserved.                                                                                                   |
| 3    | <b>PfcL1TrainDis: stride training to L1 disable.</b> Read-write. Reset: 0. 1=L1 prefetch training disabled. |
| 2:0  | Reserved.                                                                                                   |

### MSRC001\_102F Prefetch Throttling Configuration (CU\_PFTCFG)

Read-write; **Per-compute-unit**. Reset: 0000\_0000\_0000\_0000h.

The prefetch throttle mechanism, described as follows, is enabled when (PrefetchThrottlingEn==1), otherwise all L2 prefetches will be sent to the NB.

A tracking structure is defined that holds 4 NB prefetches. Each of the 4 prefetches in this structure stores a hashed physical address (PAHash[13:0]), computed as (PA[47:34] ^ PA[33:20] ^ PA[19:6]). Every Nth prefetch sent to the NB, where N is specified by CaptureThreshold, will replace the oldest entry in the tracking structure. Each entry in the tracking structure implements a DemandHit indication, that is initialized as 0 when inserted and set to 1 if a demand L2 hit also hits on that entry, where a hit is defined as when the L2 hit PAHash matches the entry PAHash.

Two counters are defined, a current accuracy count (AccCntCurrent[5:0]), warm reset to 0, and a previous accuracy count (AccCntPrevious[5:0]), warm reset to 3Fh. AccCntCurrent is incremented if the entry that is replaced by a tracking structure insertion is DemandHit==1. After TrackThreshold insertions to the tracking structure, AccCntCurrent is written to AccCntPrevious and AccCntCurrent=0. All throttling decisions are based on the value of AccCntPrevious.

DCT channel utilization also factors into the decision to throttle prefetches. DCT utilization is indicated by a code called DramBwLevel, ranging from 0 (low utilization) to 2 (high utilization). If DRAM prefetch watermark 2 has been reached then DramBwLevel=2, else if DRAM prefetch watermark 1 has been reached then DramBwLevel=1, else DramBwLevel=0. See D18F2x1B4[DcqBwThrotWm2, DcqBwThrotWm1]. Throttling occurs according to ThrottleLevel as a function of DramBwLevel:

- If ((DramBwLevel==0) && (AccCntPrevious < AccThresh0)) then throttle.
- If ((DramBwLevel==1) && (AccCntPrevious < AccThresh1)) then throttle.
- If ((DramBwLevel==2) && (AccCntPrevious < AccThresh2)) then throttle.

| Bits    | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |      |             |     |          |     |                                                  |         |                                                                                  |     |                                                      |
|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|-----|----------|-----|--------------------------------------------------|---------|----------------------------------------------------------------------------------|-----|------------------------------------------------------|
| 63:37   | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |      |             |     |          |     |                                                  |         |                                                                                  |     |                                                      |
| 36      | <b>PrefetchThrottlingEn: prefetch throttling enable.</b> BIOS: 0. 1=Prefetch throttling enabled.                                                                                                                                                                                                                                                                                                                                                                                                                                       |      |             |     |          |     |                                                  |         |                                                                                  |     |                                                      |
| 35:30   | <b>ThrottleLevel: throttling level.</b> BIOS: 0. Drop ThrottleLevel prefetches out of every every ThrottleLevel+1 prefetches. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00h</td><td>Reserved</td></tr> <tr> <td>01h</td><td>Drop 1 prefetch out of every every 2 prefetches.</td></tr> <tr> <td>3Eh-02h</td><td>Drop &lt;ThrottleLevel&gt; prefetches out of every every &lt;ThrottleLevel+1&gt; prefetches.</td></tr> <tr> <td>3Fh</td><td>Drop 63 prefetches out of every every 64 prefetches.</td></tr> </table> | Bits | Description | 00h | Reserved | 01h | Drop 1 prefetch out of every every 2 prefetches. | 3Eh-02h | Drop <ThrottleLevel> prefetches out of every every <ThrottleLevel+1> prefetches. | 3Fh | Drop 63 prefetches out of every every 64 prefetches. |
| Bits    | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |      |             |     |          |     |                                                  |         |                                                                                  |     |                                                      |
| 00h     | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |      |             |     |          |     |                                                  |         |                                                                                  |     |                                                      |
| 01h     | Drop 1 prefetch out of every every 2 prefetches.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |      |             |     |          |     |                                                  |         |                                                                                  |     |                                                      |
| 3Eh-02h | Drop <ThrottleLevel> prefetches out of every every <ThrottleLevel+1> prefetches.                                                                                                                                                                                                                                                                                                                                                                                                                                                       |      |             |     |          |     |                                                  |         |                                                                                  |     |                                                      |
| 3Fh     | Drop 63 prefetches out of every every 64 prefetches.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |      |             |     |          |     |                                                  |         |                                                                                  |     |                                                      |

|       |                                                                                                                                                                                                                                                      |
|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 29:24 | <b>AccThresh2: accuracy threshold level 2.</b> BIOS: 0. Throttle prefetches if (DramBwLevel==2) and (AccCntPrevious < AccThresh2). AccThresh2 must be programmed to be greater than AccThresh1.                                                      |
| 23:18 | <b>AccThresh1: accuracy threshold level 1.</b> BIOS: 0. Throttle prefetches if (DramBwLevel==1) and (AccCntPrevious < AccThresh1). AccThresh1 must be programmed to be greater than AccThresh0.                                                      |
| 17:12 | <b>AccThresh0: accuracy threshold level 0.</b> BIOS: 0. Throttle prefetches if (DramBwLevel==0) and (AccCntPrevious < AccThresh0).                                                                                                                   |
| 11:6  | <b>TrackThreshold: prefetch throttling tracking threshold.</b> BIOS: 0Fh. Specifies how many tracking structure writes will occur before the current accuracy count (AccCntCurrent[5:0]) replaces the previous accuracy count (AccCntPrevious[5:0]). |
| 5:0   | <b>CaptureThreshold: prefetch throttling capture threshold.</b> BIOS: 0Fh. Specifies that 1 out of every CaptureThreshold prefetches that are sent to the NB will be inserted into the tracking structure.                                           |

### MSRC001\_1030 IBS Fetch Control (IbsFetchCtl)

Reset: 0000\_0000\_0000\_0000h. See 2.6.2 [Instruction Based Sampling (IBS)].

The IBS fetch sampling engine is described as follows:

- The periodic fetch counter is an internal 20-bit counter:
  - The periodic fetch counter [19:4] is set to IbsFetchCnt[19:4] and the periodic fetch counter [3:0] is set according to IbsRandEn when IbsFetchEn is changed from 0 to 1.
  - It increments for every fetch cycle that completes when IbsFetchEn=1 and IbsFetchVal=0.
    - The periodic fetch counter is undefined when IbsFetchEn=0 or IbsFetchVal=1.
  - When IbsFetchCnt[19:4] is read it returns the current value of the periodic fetch counter [19:4].
- When the periodic fetch counter reaches {IbsFetchMaxCnt[19:4],0h} and the selected instruction fetch completes or is aborted:
  - IbsFetchVal is set to 1.
    - Drivers can't assume that IbsFetchCnt[19:4] is 0 when IbsFetchVal==1.
  - The status of the operation is written to the IBS fetch registers (this register, [MSRC001\\_1031](#) and [MSRC001\\_1032](#)).
  - An interrupt is generated as specified by [MSRC001\\_103A](#). The interrupt service routine associated with this interrupt is responsible for saving the performance information stored in IBS execution registers.

| Bits  | Description                                                                                                                                                                                                                                                                 |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 63:59 | Reserved.                                                                                                                                                                                                                                                                   |
| 58    | Reserved.                                                                                                                                                                                                                                                                   |
| 57    | <b>IbsRandEn: random instruction fetch tagging enable.</b> Read-write. 1=Bits[3:0] of the fetch counter are randomized when IbsFetchEn is set to start the fetch counter. 0=Bits[3:0] of the fetch counter are set to 0h when IbsFetchEn is set to start the fetch counter. |
| 56    | <b>IbsL2TlbMiss: instruction cache L2TLB miss.</b> Read-only; set-by-hardware. 1=The instruction fetch missed in the L2 TLB.                                                                                                                                                |
| 55    | <b>IbsL1TlbMiss: instruction cache L1TLB miss.</b> Read-only; set-by-hardware. 1=The instruction fetch missed in the L1 TLB.                                                                                                                                                |



| 54:53 | <b>IbsL1TlbPgSz: instruction cache L1TLB page size.</b> Read-only; updated-by-hardware. Indicates the page size of the translation in the L1 TLB. This field is only valid if IbsPhyAddrValid==1.<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>4 KB</td></tr> <tr> <td>01b</td><td>2 MB</td></tr> <tr> <td>10b</td><td>1 GB</td></tr> <tr> <td>11b</td><td>Reserved</td></tr> </table>                            | Bits | Description | 00b | 4 KB | 01b | 2 MB | 10b | 1 GB | 11b | Reserved |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|-----|------|-----|------|-----|------|-----|----------|
| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                      |      |             |     |      |     |      |     |      |     |          |
| 00b   | 4 KB                                                                                                                                                                                                                                                                                                                                                                                                                                             |      |             |     |      |     |      |     |      |     |          |
| 01b   | 2 MB                                                                                                                                                                                                                                                                                                                                                                                                                                             |      |             |     |      |     |      |     |      |     |          |
| 10b   | 1 GB                                                                                                                                                                                                                                                                                                                                                                                                                                             |      |             |     |      |     |      |     |      |     |          |
| 11b   | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                         |      |             |     |      |     |      |     |      |     |          |
| 52    | <b>IbsPhyAddrValid: instruction fetch physical address valid.</b> Read-only; set-by-hardware. 1=The physical address in <a href="#">MSRC001_1032</a> and the IbsL1TlbPgSz field are valid for the instruction fetch.                                                                                                                                                                                                                             |      |             |     |      |     |      |     |      |     |          |
| 51    | <b>IbsIcMiss: instruction cache miss.</b> Read-only; set-by-hardware. 1=The instruction fetch missed in the instruction cache.                                                                                                                                                                                                                                                                                                                   |      |             |     |      |     |      |     |      |     |          |
| 50    | <b>IbsFetchComp: instruction fetch complete.</b><br>Read-only; set-by-hardware. 1=The instruction fetch completed and the data is available for use by the instruction decoder.                                                                                                                                                                                                                                                                  |      |             |     |      |     |      |     |      |     |          |
| 49    | <b>IbsFetchVal: instruction fetch valid.</b> Read-only; set-by-hardware. 1=New instruction fetch data available. When this bit is set, the fetch counter stops counting and an interrupt is generated as specified by <a href="#">MSRC001_103A</a> . This bit must be cleared for the fetch counter to start counting. When clearing this bit, software can write 0000h to IbsFetchCnt[19:4] to start the fetch counter at IbsFetchMaxCnt[19:4]. |      |             |     |      |     |      |     |      |     |          |
| 48    | <b>IbsFetchEn: instruction fetch enable.</b> Read-write. 1=Instruction fetch sampling is enabled.                                                                                                                                                                                                                                                                                                                                                |      |             |     |      |     |      |     |      |     |          |
| 47:32 | <b>IbsFetchLat: instruction fetch latency.</b> Read-only; set-by-hardware. Indicates the number of clock cycles from when the instruction fetch was initiated to when the data was delivered to the core. If the instruction fetch is abandoned before the fetch completes, this field returns the number of clock cycles from when the instruction fetch was initiated to when the fetch was abandoned.                                         |      |             |     |      |     |      |     |      |     |          |
| 31:16 | <b>IbsFetchCnt[19:4].</b> Read-write; updated-by-hardware. Provides read/write access to bits[19:4] of the periodic fetch counter. Programming this field to a value greater than or equal to IbsFetchMaxCnt[19:4] results in undefined behavior.                                                                                                                                                                                                |      |             |     |      |     |      |     |      |     |          |
| 15:0  | <b>IbsFetchMaxCnt[19:4].</b> Read-write. Specifies bits[19:4] of the maximum count value of the periodic fetch counter. Programming this field to 0000h and setting IbsFetchEn results in undefined behavior. Bits[3:0] of the maximum count are always 0000b.                                                                                                                                                                                   |      |             |     |      |     |      |     |      |     |          |

#### MSRC001\_1031 IBS Fetch Linear Address (IbsFetchLinAd)

Reset: 0000\_0000\_0000\_0000h.

| Bits | Description                                                                                                                                                              |
|------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 63:0 | <b>IbsFetchLinAd: instruction fetch linear address.</b> Read-write; updated-by-hardware. Provides the linear address in canonical form for the tagged instruction fetch. |

#### MSRC001\_1032 IBS Fetch Physical Address (IbsFetchPhysAd)

Reset: 0000\_0000\_0000\_0000h.



| Bits | Description                                                                                                                                                                                                                                                                                                                                                                  |
|------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 63:0 | <b>IbsFetchPhysAd: instruction fetch physical address.</b> Read-write; updated-by-hardware. Provides the physical address for the tagged instruction fetch. The lower 12 bits are not modified by address translation, so they are always the same as the linear address. This field contains valid data only if <a href="#">MSRC001_1030</a> [IbsPhyAddrValid] is asserted. |

### MSRC001\_1033 IBS Execution Control (IbsOpCtl)

Reset: 0000\_0000\_0000\_0000h. See [2.6.2 \[Instruction Based Sampling \(IBS\)\]](#).

The IBS execution sampling engine is described as follows for IbsOpCntCtl==1. If IbsOpCntCtl==1n then references to “periodic op counter” mean “periodic cycle counter”.

- The periodic op counter is an internal 27-bit counter:
  - It is set to IbsOpCurCnt[26:0] when IbsOpEn is changed from 0 to 1.
  - It increments every dispatched op when IbsOpEn=1 and IbsOpVal=0.
    - The periodic op counter is undefined when IbsOpEn=0 or IbsOpVal=1.
  - When IbsOpCurCnt[26:0] is read then it returns the current value of the periodic micro-op counter [26:0].
- When the periodic micro-op counter reaches IbsOpMaxCnt:
  - The next dispatched micro-op is tagged if IbsOpCntCtl==1. A valid op in the next dispatched line is tagged if IbsOpCntCtl==0. See IbsOpCntCtl.
  - The periodic micro-op counter [26:7]=0; [6:0] is randomized by hardware.
- The periodic micro-op counter is not modified when a tagged micro-op is flushed.
- When a tagged micro-op is retired:
  - IbsOpVal is set to 1.
    - Drivers can't assume that IbsOpCurCnt is 0 when IbsOpVal==1.
  - The status of the operation is written to the IBS execution registers (this register, [MSRC001\\_1034](#), [MSRC001\\_1035](#), [MSRC001\\_1036](#), [MSRC001\\_1037](#), [MSRC001\\_1038](#) and [MSRC001\\_1039](#)).
  - An interrupt is generated as specified by [MSRC001\\_103A](#). The interrupt service routine associated with this interrupt is responsible for saving the performance information stored in IBS execution registers.

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                |
|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 63:59 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 58:32 | <b>IbsOpCurCnt[26:0]: periodic op counter current count.</b> Read-write; updated-by-hardware. Returns the current value of the periodic op counter.                                                                                                                                                                                                                                                                        |
| 31:27 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 26:20 | <b>IbsOpMaxCnt[26:20]: periodic op counter maximum count.</b> Read-write. See IbsOpMaxCnt[19:4].                                                                                                                                                                                                                                                                                                                           |
| 19    | <b>IbsOpCntCtl: periodic op counter count control.</b> Read-write. 1=Count dispatched <a href="#">Micro-ops</a> ; when a roll-over occurs, the counter is preloaded with a pseudorandom 7 bit value between 1 and 127. 0=Count clock cycles; a 1-of-4 round robin counter selects an op in the next dispatch line; if the op pointed to by the round robin counter is invalid, then the next younger valid op is selected. |
| 18    | <b>IbsOpVal: micro-op sample valid.</b> Read-write; set-by-hardware. 1=New instruction execution data available; the periodic op counter is disabled from counting. An interrupt may be generated when this bit is set as specified by <a href="#">MSRC001_103A</a> [LvtOffset].                                                                                                                                           |
| 17    | <b>IbsOpEn: micro-op sampling enable.</b> Read-write. 1=Instruction execution sampling enabled.                                                                                                                                                                                                                                                                                                                            |

| 16          | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                            |      |             |             |          |             |                            |
|-------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|-------------|----------|-------------|----------------------------|
| 15:0        | <p><b>IbsOpMaxCnt[19:4]: periodic op counter maximum count.</b> Read-write. IbsOpMaxCnt[26:0] = {IbsOpMaxCnt[26:20], IbsOpMaxCnt[19:4], 0000b}. Specifies maximum count value of the periodic op counter. Bits [3:0] of the maximum count are always 0000b.</p> <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>0008h-0000h</td><td>Reserved</td></tr> <tr> <td>FFFFh-0009h</td><td>&lt;IbsOpMaxCnt[19:4]*16&gt; ops</td></tr> </table> | Bits | Description | 0008h-0000h | Reserved | FFFFh-0009h | <IbsOpMaxCnt[19:4]*16> ops |
| Bits        | Description                                                                                                                                                                                                                                                                                                                                                                                                                                          |      |             |             |          |             |                            |
| 0008h-0000h | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                             |      |             |             |          |             |                            |
| FFFFh-0009h | <IbsOpMaxCnt[19:4]*16> ops                                                                                                                                                                                                                                                                                                                                                                                                                           |      |             |             |          |             |                            |

### MSRC001\_1034 IBS Op Logical Address (IbsOpRip)

Reset: 0000\_0000\_0000\_0000h.

| Bits | Description                                                                                                                                                        |
|------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 63:0 | <b>IbsOpRip: micro-op linear address.</b> Read-write; updated-by-hardware. Linear address in canonical form for the instruction that contains the tagged micro-op. |

### MSRC001\_1035 IBS Op Data (IbsOpData)

| Bits  | Description                                                                                                                                                                                                                  |
|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 63:41 | Reserved.                                                                                                                                                                                                                    |
| 40    | <p><b>IbsOpMicrocode.</b><br/>Value: 0.<br/>1=Tagged operation from microcode.</p>                                                                                                                                           |
| 39    | <p><b>IbsOpBrnFuse: fused branch micro-op.</b><br/>Read-write; updated-by-hardware. Reset: 0.<br/>1=Tagged operation was a fused branch micro-op. Support indicated by <a href="#">CPUID Fn8000_001B_EAX</a>[OpBrnFuse].</p> |
| 38    | <p><b>IbsOpRipInvalid: RIP is invalid.</b> Read-write; updated-by-hardware. Reset: 0. 1=Tagged operation RIP is invalid. Support indicated by <a href="#">CPUID Fn8000_001B_EAX</a>[RipInvalidChk].</p>                      |
| 37    | <p><b>IbsOpBrnRet: branch micro-op retired.</b> Read-write; updated-by-hardware. Reset: 0. 1=Tagged operation was a branch micro-op that retired.</p>                                                                        |
| 36    | <p><b>IbsOpBrnMisp: mispredicted branch micro-op.</b> Read-write; updated-by-hardware. Reset: 0. 1=Tagged operation was a branch micro-op that was mispredicted. Qualified by IbsOpBrnRet==1.</p>                            |
| 35    | <p><b>IbsOpBrnTaken: taken branch micro-op.</b> Read-write; updated-by-hardware. Reset: 0. 1=Tagged operation was a branch micro-op that was taken. Qualified by IbsOpBrnRet==1.</p>                                         |
| 34    | <p><b>IbsOpReturn: return micro-op.</b> Read-write; updated-by-hardware. Reset: 0. 1=Tagged operation was return micro-op. Qualified by (IbsOpBrnRet==1).</p>                                                                |
| 33:32 | Reserved.                                                                                                                                                                                                                    |

|       |                                                                                                                                                                                                                                                                                       |
|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:16 | <b>IbsTagToRetCtr: micro-op tag to retire count.</b> Read-write; updated-by-hardware. Reset: 0. This field returns the number of cycles from when the micro-op was tagged to when the micro-op was retired. This field is equal to IbsCompToRetCtr when the tagged micro-op is a NOP. |
| 15:0  | <b>IbsCompToRetCtr: micro-op completion to retire count.</b> Read-write; updated-by-hardware. Reset: 0. This field returns the number of cycles from when the micro-op was completed to when the micro-op was retired.                                                                |

### MSRC001\_1036 IBS Op Data 2 (IbsOpData2)

Reset: 0000\_0000h. Northbridge data is only valid for load operations that miss both the L1 data cache and the L2 cache. If a load operation crosses a cache line boundary, the data returned in this register is the data for the access to the lower cache line.

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |      |             |    |                 |    |          |    |                                                       |    |                               |    |                           |    |          |    |          |    |                                                |
|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|----|-----------------|----|----------|----|-------------------------------------------------------|----|-------------------------------|----|---------------------------|----|----------|----|----------|----|------------------------------------------------|
| 63:32 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |      |             |    |                 |    |          |    |                                                       |    |                               |    |                           |    |          |    |          |    |                                                |
| 31:6  | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |      |             |    |                 |    |          |    |                                                       |    |                               |    |                           |    |          |    |          |    |                                                |
| 5     | <b>NbIbsReqCacheHitSt: IBS cache hit state.</b> Read-write; updated-by-hardware. Valid when the data source type is Cache(2h). 0=M State. 1=O State.                                                                                                                                                                                                                                                                                                                                                                                                                                      |      |             |    |                 |    |          |    |                                                       |    |                               |    |                           |    |          |    |          |    |                                                |
| 4     | <b>NbIbsReqDstNode: IBS request destination node.</b> Read-write; updated-by-hardware. 0=The request is serviced by the NB in the same node as the core. 1=The request is serviced by the NB in a different node than the core. Valid when NbIbsReqSrc is non-zero.                                                                                                                                                                                                                                                                                                                       |      |             |    |                 |    |          |    |                                                       |    |                               |    |                           |    |          |    |          |    |                                                |
| 3     | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |      |             |    |                 |    |          |    |                                                       |    |                               |    |                           |    |          |    |          |    |                                                |
| 2:0   | <b>NbIbsReqSrc: northbridge IBS request data source.</b> Read-write. <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>0h</td><td>No valid status</td></tr> <tr> <td>1h</td><td>Reserved</td></tr> <tr> <td>2h</td><td>Cache: data returned from another compute-unit cache.</td></tr> <tr> <td>3h</td><td>DRAM: data returned from DRAM</td></tr> <tr> <td>4h</td><td>Reserved for remote cache</td></tr> <tr> <td>5h</td><td>Reserved</td></tr> <tr> <td>6h</td><td>Reserved</td></tr> <tr> <td>7h</td><td>Other: data returned from MMIO/Config/PCI/APIC</td></tr> </table> | Bits | Description | 0h | No valid status | 1h | Reserved | 2h | Cache: data returned from another compute-unit cache. | 3h | DRAM: data returned from DRAM | 4h | Reserved for remote cache | 5h | Reserved | 6h | Reserved | 7h | Other: data returned from MMIO/Config/PCI/APIC |
| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |      |             |    |                 |    |          |    |                                                       |    |                               |    |                           |    |          |    |          |    |                                                |
| 0h    | No valid status                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |      |             |    |                 |    |          |    |                                                       |    |                               |    |                           |    |          |    |          |    |                                                |
| 1h    | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |      |             |    |                 |    |          |    |                                                       |    |                               |    |                           |    |          |    |          |    |                                                |
| 2h    | Cache: data returned from another compute-unit cache.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |      |             |    |                 |    |          |    |                                                       |    |                               |    |                           |    |          |    |          |    |                                                |
| 3h    | DRAM: data returned from DRAM                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |      |             |    |                 |    |          |    |                                                       |    |                               |    |                           |    |          |    |          |    |                                                |
| 4h    | Reserved for remote cache                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |      |             |    |                 |    |          |    |                                                       |    |                               |    |                           |    |          |    |          |    |                                                |
| 5h    | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |      |             |    |                 |    |          |    |                                                       |    |                               |    |                           |    |          |    |          |    |                                                |
| 6h    | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |      |             |    |                 |    |          |    |                                                       |    |                               |    |                           |    |          |    |          |    |                                                |
| 7h    | Other: data returned from MMIO/Config/PCI/APIC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |      |             |    |                 |    |          |    |                                                       |    |                               |    |                           |    |          |    |          |    |                                                |

### MSRC001\_1037 IBS Op Data 3 (IbsOpData3)

Reset: 0000\_0000\_0000\_0000h. If a load or store operation crosses a 128-bit boundary, the data returned in this register is the data for the access to the data below the 128-bit boundary.

| Bits  | Description                                                                                                                                                                                         |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 63:48 | <b>IbsTlbRefillLat: L1 DTLB refill latency.</b><br>Read-only. Value: 0.<br>The number of cycles from when a L1 DTLB refill is triggered by a tagged op to when the L1 DTLB fill has been completed. |

| 47:32 | <b>IbsDcMissLat: data cache miss latency.</b> Read-write; updated-by-hardware. Indicates the number of clock cycles from when a miss is detected in the data cache to when the data was delivered to the core. The value returned by this counter is not valid for data cache writes or prefetch instructions.                                                                                                                                                                             |      |             |    |                          |    |      |    |      |    |    |    |    |    |    |       |          |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|----|--------------------------|----|------|----|------|----|----|----|----|----|----|-------|----------|
| 31:26 | <b>IbsOpDcMissOpenMemReqs: outstanding memory requests on DC fill.</b><br>Read-only. Value: 0.<br>The number of allocated, valid DC MABs when the MAB corresponding to a tagged DC miss op is deallocated. Includes the MAB allocated by the sampled op. 00000b=No information provided.                                                                                                                                                                                                   |      |             |    |                          |    |      |    |      |    |    |    |    |    |    |       |          |
| 25:22 | <b>IbsOpMemWidth: load/store size in bytes.</b><br>Read-only. Value: 0.<br>Report the number of bytes the load or store is attempting to access.<br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>0h</td><td>No information provided.</td></tr> <tr> <td>1h</td><td>Byte</td></tr> <tr> <td>2h</td><td>Word</td></tr> <tr> <td>3h</td><td>DW</td></tr> <tr> <td>4h</td><td>QW</td></tr> <tr> <td>5h</td><td>OW</td></tr> <tr> <td>Fh-6h</td><td>Reserved</td></tr> </table> | Bits | Description | 0h | No information provided. | 1h | Byte | 2h | Word | 3h | DW | 4h | QW | 5h | OW | Fh-6h | Reserved |
| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |      |             |    |                          |    |      |    |      |    |    |    |    |    |    |       |          |
| 0h    | No information provided.                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |      |             |    |                          |    |      |    |      |    |    |    |    |    |    |       |          |
| 1h    | Byte                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |      |             |    |                          |    |      |    |      |    |    |    |    |    |    |       |          |
| 2h    | Word                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |      |             |    |                          |    |      |    |      |    |    |    |    |    |    |       |          |
| 3h    | DW                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |      |             |    |                          |    |      |    |      |    |    |    |    |    |    |       |          |
| 4h    | QW                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |      |             |    |                          |    |      |    |      |    |    |    |    |    |    |       |          |
| 5h    | OW                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |      |             |    |                          |    |      |    |      |    |    |    |    |    |    |       |          |
| Fh-6h | Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |      |             |    |                          |    |      |    |      |    |    |    |    |    |    |       |          |
| 21    | <b>IbsSwPf: software prefetch.</b><br>Read-only. Value: 0.<br>1=The op is a software prefetch.                                                                                                                                                                                                                                                                                                                                                                                             |      |             |    |                          |    |      |    |      |    |    |    |    |    |    |       |          |
| 20    | <b>IbsL2Miss: L2 cache miss for the sampled operation.</b><br>Read-only. Value: 0.<br>1=The operation missed in the L2, regardless of whether the op initiated the request to the L2.                                                                                                                                                                                                                                                                                                      |      |             |    |                          |    |      |    |      |    |    |    |    |    |    |       |          |
| 19    | <b>IbsDcL2TlbHit1G: data cache L2TLB hit in 1G page.</b><br>Read-write; updated-by-hardware.<br>1=The physical address for the tagged load or store operation was present in a 1G page table entry in the data cache L2TLB.                                                                                                                                                                                                                                                                |      |             |    |                          |    |      |    |      |    |    |    |    |    |    |       |          |
| 18    | <b>IbsDcPhyAddrValid: data cache physical address valid.</b> Read-write; updated-by-hardware. 1=The physical address in <a href="#">MSRC001_1039</a> is valid for the load or store operation.                                                                                                                                                                                                                                                                                             |      |             |    |                          |    |      |    |      |    |    |    |    |    |    |       |          |
| 17    | <b>IbsDcLinAddrValid: data cache linear address valid.</b> Read-write; updated-by-hardware. 1=The linear address in <a href="#">MSRC001_1038</a> is valid for the load or store operation.                                                                                                                                                                                                                                                                                                 |      |             |    |                          |    |      |    |      |    |    |    |    |    |    |       |          |
| 16    | <b>DcMissNoMabAlloc: DC miss with no MAB allocated.</b> Read-write; updated-by-hardware. 1=The tagged load or store operation hit on an already allocated MAB.                                                                                                                                                                                                                                                                                                                             |      |             |    |                          |    |      |    |      |    |    |    |    |    |    |       |          |
| 15    | <b>IbsDcLockedOp: locked operation.</b> Read-write; updated-by-hardware. 1=Tagged load or store operation is a locked operation.                                                                                                                                                                                                                                                                                                                                                           |      |             |    |                          |    |      |    |      |    |    |    |    |    |    |       |          |
| 14    | <b>IbsDcUcMemAcc: UC memory access.</b> Read-write; updated-by-hardware. 1=Tagged load or store operation accessed uncacheable memory.                                                                                                                                                                                                                                                                                                                                                     |      |             |    |                          |    |      |    |      |    |    |    |    |    |    |       |          |
| 13    | <b>IbsDcWcMemAcc: WC memory access.</b> Read-write; updated-by-hardware. 1=Tagged load or store operation accessed write combining memory.                                                                                                                                                                                                                                                                                                                                                 |      |             |    |                          |    |      |    |      |    |    |    |    |    |    |       |          |
| 12:11 | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |      |             |    |                          |    |      |    |      |    |    |    |    |    |    |       |          |
| 10    | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |      |             |    |                          |    |      |    |      |    |    |    |    |    |    |       |          |

|   |                                                                                                                                                                                                                       |
|---|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 9 | Reserved.                                                                                                                                                                                                             |
| 8 | <b>IbsDcMisAcc: misaligned access.</b> Read-write; updated-by-hardware. 1=The tagged load or store operation crosses a 128 bit address boundary.                                                                      |
| 7 | <b>IbsDcMiss: data cache miss.</b> Read-write; updated-by-hardware. 1=The cache line used by the tagged load or store was not present in the data cache.                                                              |
| 6 | <b>IbsDcL2tlbHit2M: data cache L2TLB hit in 2M page.</b> Read-write; updated-by-hardware. 1=The physical address for the tagged load or store operation was present in a 2M page table entry in the data cache L2TLB. |
| 5 | <b>IbsDcL1TlbHit1G: data cache L1TLB hit in 1G page.</b> Read-write; updated-by-hardware. 1=The physical address for the tagged load or store operation was present in a 1G page table entry in the data cache L1TLB. |
| 4 | <b>IbsDcL1TlbHit2M: data cache L1TLB hit in 2M page.</b> Read-write; updated-by-hardware. 1=The physical address for the tagged load or store operation was present in a 2M page table entry in the data cache L1TLB. |
| 3 | <b>IbsDcL2TlbMiss: data cache L2TLB miss.</b> Read-write; updated-by-hardware. 1=The physical address for the tagged load or store operation was not present in the data cache L2TLB.                                 |
| 2 | <b>IbsDcL1tlbMiss: data cache L1TLB miss.</b> Read-write; updated-by-hardware. 1=The physical address for the tagged load or store operation was not present in the data cache L1TLB.                                 |
| 1 | <b>IbsStOp: store op.</b> Read-write; updated-by-hardware. 1=Tagged operation is a store operation.                                                                                                                   |
| 0 | <b>IbsLdOp: load op.</b> Read-write; updated-by-hardware. 1=Tagged operation is a load operation.                                                                                                                     |

#### MSRC001\_1038 IBS DC Linear Address (IbsDcLinAd)

Reset: 0000\_0000\_0000\_0000h.

| Bits | Description                                                                                                                                                                                                                                    |
|------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 63:0 | <b>IbsDcLinAd.</b> Read-write; updated-by-hardware. Provides the linear address in canonical form for the tagged load or store operation. This field contains valid data only if <a href="#">MSRC001_1037</a> [IbsDcLinAddrValid] is asserted. |

#### MSRC001\_1039 IBS DC Physical Address (IbsDcPhysAd)

| Bits  | Description                                                                                                                                                                                                                                                                                                                                                                              |
|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 63:48 | RAZ.                                                                                                                                                                                                                                                                                                                                                                                     |
| 47:0  | <b>IbsDcPhysAd: load or store physical address.</b> Read-write; updated-by-hardware. Reset: 0. Provides the physical address for the tagged load or store operation. The lower 12 bits are not modified by address translation, so they are always the same as the linear address. This field contains valid data only if <a href="#">MSRC001_1037</a> [IbsDcPhysAddrValid] is asserted. |

#### MSRC001\_103A IBS Control

GP-write.

| Bits  | Description                                                                                                                                                |
|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 63:32 | Reserved.                                                                                                                                                  |
| 31:9  | Reserved.                                                                                                                                                  |
| 8     | <b>LvtOffsetVal: local vector table offset valid.</b> <a href="#">MSRC001_103A</a> [LvtOffsetVal] is an alias of <a href="#">D18F3x1CC</a> [LvtOffsetVal]. |
| 7:4   | Reserved.                                                                                                                                                  |
| 3:0   | <b>LvtOffset: local vector table offset.</b> <a href="#">MSRC001_103A</a> [LvtOffset] is an alias of <a href="#">D18F3x1CC</a> [LvtOffset].                |

### **MSRC001\_103B IBS Branch Target Address (BP\_IBSTGT\_RIP)**

Reset: 0000\_0000\_0000\_0000h. Support for this register indicated by [CPUID Fn8000\\_001B\\_EAX](#)[BrnTrgt].

| Bits | Description                                                                                                                                                                                                     |
|------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 63:0 | <b>IbsBrTarget.</b> Read-write; updated-by-hardware. The logical address in canonical form for the branch target. Contains a valid target if non-0. Qualified by <a href="#">MSRC001_1035</a> [IbsOpBrnRet]==1. |

### **MSRC001\_1090 Processor Feedback Constants 0**

Read-write; [Per-compute-unit](#).

| Bits  | Description                                       |
|-------|---------------------------------------------------|
| 63:32 | Reserved.                                         |
| 31:16 | Reserved.                                         |
| 15:8  | <b>RefCountScale.</b> Reset: Product-specific.    |
| 7:0   | <b>ActualCountScale.</b> Reset: Product-specific. |



### 3.23 Core Performance Counter Events

This section provides the core performance counter events that may be selected through [MSRC001\\_020\[A,8,6,4,2,0\]\[EventSelect,UnitMask\]](#). See that register and [MSRC001\\_020\[B,9,7,5,3,1\]](#) [Performance Event Counter (PERF\_CTR[5:0])].

For NB performance counter events see [2.6.1.2 \[NB Performance Monitor Counters\]](#) and [3.24 \[NB Performance Counter Events\]](#).

#### 3.23.1 PMCx0[1F:00] Events (FP)

##### PMCx000 FPU Pipe Assignment

[PERF\\_CTL\[3\]](#). The number of operations (uops) and dual-pipe uops dispatched to each of the 3 FPU execution pipelines. This event reflects how busy the FPU pipelines are and may be used for workload characterization. This includes all operations performed by x87, MMX, and SSE instructions, including moves. Each increment represents a one-cycle dispatch event. This event is a speculative event. (See [PMCx0CB](#)). Since this event includes non-numeric operations it is not suitable for measuring MFLOPS. The number of events logged per cycle can vary from 0 to 6 and must use [PERF\\_CTL\[3\]](#).

| UnitMask | Description                                     |
|----------|-------------------------------------------------|
| 7        | Reserved.                                       |
| 6        | Total number dual-pipe uops assigned to Pipe 2. |
| 5        | Total number dual-pipe uops assigned to Pipe 1. |
| 4        | Total number dual-pipe uops assigned to Pipe 0. |
| 3        | Reserved.                                       |
| 2        | Total number uops assigned to Pipe 2.           |
| 1        | Total number uops assigned to Pipe 1.           |
| 0        | Total number uops assigned to Pipe 0.           |

##### PMCx001 FP Scheduler Empty

[PERF\\_CTL\[5:3\]](#). This is a speculative event. The number of cycles in which the FPU scheduler is empty. Note that some ops like FP loads bypass the scheduler; see the FP MAS for the full list of “no pipe” ops that bypass the scheduler. Invert this ([MSRC001\\_020\[A,8,6,4,2,0\]\[Inv\]==1](#)) to count cycles in which at least one FPU operation is present in the FPU.

##### PMCx003 Retired SSE/AVX Operations

[PERF\\_CTL\[3\]](#). This is a retire-based event. The number of retired SSE/AVX FLOPS. The number of events logged per cycle can vary from 0 to 32.

| UnitMask | Description                                                          |
|----------|----------------------------------------------------------------------|
| 7        | Double precision multiply-add FLOPS. Multiply-add counts as 2 FLOPS. |
| 6        | Double precision divide/square root FLOPS.                           |
| 5        | Double precision multiply FLOPS.                                     |
| 4        | Double precision add/subtract FLOPS.                                 |



|   |                                                                      |
|---|----------------------------------------------------------------------|
| 3 | Single precision multiply-add FLOPS. Multiply-add counts as 2 FLOPS. |
| 2 | Single-precision divide/square root FLOPS.                           |
| 1 | Single-precision multiply FLOPS.                                     |
| 0 | Single-precision add/subtract FLOPS.                                 |

#### PMCx004 Number of Move Elimination and Scalar Op Optimization

[PERF\\_CTL\[3\]](#). This is a dispatch based speculative event, and is useful for measuring the effectiveness of the Move elimination and Scalar code optimization schemes. The number of events logged per cycle can vary from 0 to 8 and must use [PERF\\_CTL\[3\]](#).

| UnitMask | Description                                                                         |
|----------|-------------------------------------------------------------------------------------|
| 7:4      | Reserved.                                                                           |
| 3        | Number of Scalar ops optimized.                                                     |
| 2        | Number of Ops that are candidates for optimization (have Z-bit either set or pass). |
| 1        | Number of SSE Move Ops eliminated.                                                  |
| 0        | Number of SSE Move Ops.                                                             |

#### PMCx005 Retired Serializing Ops

[PERF\\_CTL\[5:3\]](#). The number of serializing ops retired.

| UnitMask | Description                                                                                         |
|----------|-----------------------------------------------------------------------------------------------------|
| 7:4      | Reserved.                                                                                           |
| 3        | x87 control word mispredict traps due to mispredictions in RC or PC, or changes in mask bits.       |
| 2        | x87 bottom-executing uops retired.                                                                  |
| 1        | SSE control word mispredict traps due to mispredictions in RC, FTZ or DAZ, or changes in mask bits. |
| 0        | SSE bottom-executing uops retired.                                                                  |

#### PMCx006 Number of Cycles that a Bottom-Execute uop is in the FP Scheduler

[PERF\\_CTL\[5:3\]](#). This is a speculative event.

### 3.23.2 PMCx0[3F:20] Events (LS)

#### PMCx020 Segment Register Loads

[PERF\\_CTL\[5:0\]](#). The number of segment register loads performed.

| UnitMask | Description |
|----------|-------------|
| 7        | Reserved.   |
| 6        | HS          |
| 5        | GS          |
| 4        | FS          |

|   |    |
|---|----|
| 3 | DS |
| 2 | SS |
| 1 | CS |
| 0 | ES |

#### PMCx021 Pipeline Restart Due to Self-Modifying Code

**PERF\_CTL[5:0]**. The number of pipeline restarts that were caused by self-modifying code (a store that hits any instruction that's been fetched for execution beyond the instruction doing the store).

#### PMCx022 Pipeline Restart Due to Probe Hit

**PERF\_CTL[5:0]**. The number of pipeline restarts caused by an invalidating probe hitting on a speculative out-of-order load.

#### PMCx023 Load Queue/Store Queue Full

**PERF\_CTL[2:0]**. The number of cycles that the load queue(LDQ) or store queue (STQ) is full. The load queue holds loads that missed the data cache and are waiting on a refill; the store queue holds stores waiting to retire. This condition stalls further data cache accesses, although such stalls may be overlapped by independent instruction execution.

| UnitMask | Description                                         |
|----------|-----------------------------------------------------|
| 7:2      | Reserved.                                           |
| 1        | The number of cycles that the store buffer is full. |
| 0        | The number of cycles that the load buffer is full.  |

#### PMCx024 Locked Operations

**PERF\_CTL[5:0]**. This event covers locked operations performed and their non-speculative execution time.

#### PMCx026 Retired CLFLUSH Instructions

**PERF\_CTL[5:0]**. The number of retired CLFLUSH instructions. This is a non-speculative event.

#### PMCx027 Retired CPUID Instructions

**PERF\_CTL[5:0]**. The number of CPUID instructions retired.

#### PMCx029 LS Dispatch

**PERF\_CTL[5:0]**. Counts the number of operations dispatched to the LS unit.

| UnitMask | Description     |
|----------|-----------------|
| 7:3      | Reserved.       |
| 2        | Load-op-Stores. |

|   |         |
|---|---------|
| 1 | Stores. |
| 0 | Loads.  |

### PMCx02A Canceled Store to Load Forward Operations

[PERF\\_CTL\[5:0\]](#). Counts the number of canceled store to load forward operations.

| UnitMask | Description                                                                           |
|----------|---------------------------------------------------------------------------------------|
| 7:2      | Reserved.                                                                             |
| 1        | Physical tag mismatch.                                                                |
| 0        | Either “store is smaller than load” or “different starting byte but partial overlap”. |

### PMCx02B SMIs Received

[PERF\\_CTL\[5:0\]](#). Counts the number of SMIs received.

### PMCx030 Executed CLFLUSH Instructions

[PERF\\_CTL\[5:0\]](#). The number of executed CLFLUSH instructions. This is a speculative event.

### PMCx032 Misaligned Stores

[PERF\\_CTL\[5:0\]](#). The number of misaligned stores.

### PMCx034 FP +Load Buffer Stall

[PERF\\_CTL\[5:0\]](#). The number of loads stalled due to buffer full.

### PMCx035 STLF

[PERF\\_CTL\[5:0\]](#). Number of STLF hits.

## 3.23.3 PMCx0[5F:40] Events (DC)

### PMCx040 Data Cache Accesses

[PERF\\_CTL\[5:0\]](#). The number of accesses to the data cache for load and store references. This may include certain microcode scratchpad accesses, although these are generally rare. This event is a speculative event. The number of events logged per cycle can vary from 0 to 2.

### PMCx041 Data Cache Misses

[PERF\\_CTL\[5:0\]](#). The number of data cache references which missed in the data cache. This event is a speculative event. Only the first miss for a given line is included; access attempts by other instructions while the refill is still pending are not included in this event. Each event reflects one 64 B cache line refill, and counts of this event are the same as, or very close to, the combined count for [PMCx042](#). The number of events logged per

cycle can vary from 0 to 2.

| UnitMask | Description                                                    |
|----------|----------------------------------------------------------------|
| 7:2      | Reserved.                                                      |
| 1        | First streaming store to a 64 B cache line.                    |
| 0        | First data cache miss or streaming store to a 64 B cache line. |

#### PMCx042 Data Cache Refills from L2 or System

[PERF\\_CTL\[5:0\]](#). The number of data cache refills satisfied from the L2 cache and/or the system. Each increment reflects a 64 B transfer. This event is a speculative event.

| UnitMask | Description                                        |
|----------|----------------------------------------------------|
| 7:5      | Reserved.                                          |
| 4        | No-acknowledge fill response.                      |
| 3        | Fill with read data error.                         |
| 2        | Reserved.                                          |
| 1        | Early valid status turned out to be invalid.       |
| 0        | Fill with good data. (Final valid status is valid) |

#### PMCx043 Data Cache Refills from System

[PERF\\_CTL\[2:0\]](#). The number of L1 cache refills satisfied from the system (system memory or another cache), as opposed to the L2. Each increment reflects a 64 B transfer. This event is a speculative event.

#### PMCx045 Unified TLB Hit

[PERF\\_CTL\[2:0\]](#). The number of TLB accesses that miss in the L1 DTLB or L1 and L2 ITLBs and hit in the unified TLB (UCTLB). This event is a speculative event.

| UnitMask | Description                           |
|----------|---------------------------------------|
| 7        | Reserved.                             |
| 6        | 1 GB unified TLB hit for instruction. |
| 5        | 2 MB unified TLB hit for instruction. |
| 4        | 4 KB unified TLB hit for instruction. |
| 3        | Reserved.                             |
| 2        | 1 GB unified TLB hit for data.        |
| 1        | 2 MB unified TLB hit for data.        |
| 0        | 4 KB unified TLB hit for data.        |

**PMCx046 Unified TLB Miss**

**PERF\_CTL[2:0]**. The number of TLB accesses that miss in all TLBs. This event is a speculative event.

| UnitMask | Description                            |
|----------|----------------------------------------|
| 7        | Reserved.                              |
| 6        | 1 GB unified TLB miss for instruction. |
| 5        | 2 MB unified TLB miss for instruction. |
| 4        | 4 KB unified TLB miss for instruction. |
| 3        | Reserved.                              |
| 2        | 1 GB unified TLB miss for data.        |
| 1        | 2 MB unified TLB miss for data.        |
| 0        | 4 KB unified TLB miss for data.        |

**PMCx047 Misaligned Accesses**

**PERF\_CTL[5:0]**. The number of data cache accesses that are misaligned. These are accesses which cross an 8 B boundary. They incur an extra cache access (reflected in **PMCx040**), and an extra cycle of latency on reads. This event is a speculative event.

**PMCx04B Prefetch Instructions Dispatched**

**PERF\_CTL[5:0]**. The number of prefetch instructions dispatched by the decoder. Such instructions may or may not cause a cache line transfer. Any Dcache and L2 accesses, hits and misses by prefetch instructions are included in these types of events. This event is a speculative event.

| UnitMask | Description                       |
|----------|-----------------------------------|
| 7:3      | Reserved.                         |
| 2        | NTA (PrefetchNTA)                 |
| 1        | Store (PrefetchW)                 |
| 0        | Load (Prefetch, PrefetchT0/T1/T2) |

**PMCx052 Ineffective Software Prefetchs**

**PERF\_CTL[5:0]**. The number of software prefetches that did not fetch data outside of the processor core.

| UnitMask | Description                      |
|----------|----------------------------------|
| 7:4      | Reserved.                        |
| 3        | Software prefetch hit in the L2. |
| 2:1      | Reserved.                        |
| 0        | Software prefetch hit in the L1. |

**3.23.4 PMCx[1:0][7F:60] Events (CU)****PMCx060 Command Related to Victim Buffers**[PERF\\_CTL\[2:0\]](#).

| UnitMask | Description          |
|----------|----------------------|
| 7        | Lock                 |
| 6:5      | Reserved.            |
| 4        | Clean Victim Command |
| 3        | Write Victim Block   |
| 2:0      | Reserved.            |

**PMCx061 Command Related to Masked Operations**

[PERF\\_CTL\[2:0\]](#). Count Masked Byte and DW reads and writes to the NB. Byte sized read and write commands can request the transfer of up to 32 bytes. DW sized read and write commands can request the transfer of up to 32 DW's. Combining of the WC memory type can cause 1 B/DW write to represent multiple stores.

| UnitMask | Description       |
|----------|-------------------|
| 7:6      | Reserved.         |
| 5        | Write Double-word |
| 4        | Write Byte        |
| 3        | Reserved.         |
| 2        | Read Double-word  |
| 1        | Reserved.         |
| 0        | Read Byte         |

**PMCx062 Command Related to Read Block Operations**[PERF\\_CTL\[2:0\]](#).

| UnitMask | Description                    |
|----------|--------------------------------|
| 7        | Reserved.                      |
| 6        | Read Block Speculative Shared. |
| 5        | RdBlkSpecMod.                  |
| 4        | RdBlkSpec.                     |
| 3        | Reserved.                      |
| 2        | Read Block Shared.             |
| 1        | RdBlkMod.                      |
| 0        | Read Block.                    |

**PMCx063 Command Related to Change to Dirty Operations**[PERF\\_CTL\[2:0\]](#).

| UnitMask | Description      |
|----------|------------------|
| 7:5      | Reserved.        |
| 4        | Change to Dirty. |
| 3:0      | Reserved.        |

### PMCx064 Dram System Request

[PERF\\_CTL\[2:0\]](#).

### PMCx065 Memory Requests by Type

[PERF\\_CTL\[2:0\]](#). These events reflect accesses to uncacheable (UC), write-combining (WC), and streaming store (SS) activity to WB memory.

| UnitMask | Description                                                                                               |
|----------|-----------------------------------------------------------------------------------------------------------|
| 7        | Requests to non-cacheable (WC+/SS, but not WC) memory, consisting of reads and 64 B sized buffer flushes. |
| 6:2      | Reserved.                                                                                                 |
| 1        | Requests to non-cacheable (WC, but not WC+/SS) memory, consisting of reads and 64 B sized buffer flushes. |
| 0        | Requests to non-cacheable (UC) memory.                                                                    |

### PMCx067 Data Cache Prefetches

| UnitMask | Description        |
|----------|--------------------|
| 7:2      | Reserved.          |
| 1        | Prefetch attempts. |
| 0        | Reserved.          |

### PMCx068 MAB Requests

[PERF\\_CTL\[2:0\]](#). Events [PMCx068](#) and [PMCx069](#) reflect utilization of the Miss Address buffers (MABs), which handle IC, DC, TLB, WCC, and WCB related requests. The UnitMask[BufferID] is an encoded value which selects one of the MABs. [PMCx068](#) counts the number of cacheable L2 misses handled by the selected MAB; [PMCx069](#) counts the number of cycles the selected MAB is busy waiting for the NB response. The average latency seen by the selected MAB is the number of cycles spent waiting ([PMCx069](#)) divided by the number of requests ([PMCx068](#)).

| UnitMask | Description                                                                                                                                                     |      |             |      |        |        |          |
|----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|------|--------|--------|----------|
| 7:0      | <b>BufferID.</b> <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>27-0</td><td>MAB ID</td></tr> <tr> <td>255-28</td><td>Reserved</td></tr> </table> | Bits | Description | 27-0 | MAB ID | 255-28 | Reserved |
| Bits     | Description                                                                                                                                                     |      |             |      |        |        |          |
| 27-0     | MAB ID                                                                                                                                                          |      |             |      |        |        |          |
| 255-28   | Reserved                                                                                                                                                        |      |             |      |        |        |          |

### PMCx069 MAB Wait Cycles

[PERF\\_CTL\[2:0\]](#).

See [PMCx068](#).

| UnitMask | Description                                                  |
|----------|--------------------------------------------------------------|
| 7:0      | <b>BufferID.</b><br>See: <a href="#">PMCx068</a> [BufferID]. |

### PMCx06C System Response by Coherence State

[PERF\\_CTL\[2:0\]](#). The number of responses from the system for cache refill requests. The UnitMask may be used to select specific cache coherency states. Each increment represents one 64 B cache line transferred from the system (DRAM or another cache, including another core on the same node) to the data cache, instruction cache or L2 cache (for data prefetcher and TLB table walks). Modified-state responses may be for Dcache store miss refills, PrefetchW software prefetches, hardware prefetches for a store-miss stream, or Change-to-Dirty requests that get a dirty (Owned) probe hit in another cache. Exclusive responses may be for any Icache refill, Dcache load miss refill, other software prefetches, hardware prefetches for a load-miss stream, or TLB table walks that miss in the L2 cache; Shared responses may be for any of those that hit a clean line in another cache.

| UnitMask | Description        |
|----------|--------------------|
| 7:6      | Reserved.          |
| 5        | Modified unwritten |
| 4        | Data Error         |
| 3        | Owned              |
| 2        | Shared             |
| 1        | Modified           |
| 0        | Exclusive          |

### PMCx06D Octwords Written to System

[PERF\\_CTL\[2:0\]](#). The number of OW (16 B) data transfers from the processor to the system. These may be part of a 64 B cache line writeback or a 64 B dirty probe hit response, each of which would cause four increments; or a partial or complete Write Combining buffer flush (Sized Write), which could cause from one to four increments.

| UnitMask | Description        |
|----------|--------------------|
| 7:6      | Reserved.          |
| 5:1      | Reserved.          |
| 0        | OW write transfer. |

### PMCx075 Cache Cross-invalidates

These reflect internal probes for Icache or Dcache misses that hit in the Dcache or Icache, causing the line to be



invalidated. These may result from code modification, data being located too close to code, or virtual address aliasing. The aliasing cases arise when a physical memory location is referenced via two or more virtual addresses which differ in bits 14:12. Such aliasing cases are generally uncommon.

| UnitMask | Description                                                                                    |
|----------|------------------------------------------------------------------------------------------------|
| 7:4      | Reserved.                                                                                      |
| 3        | IC Invalidates DC (execution of recently modified code, or modified data too close to code).   |
| 2        | IC Invalidates IC (aliasing)                                                                   |
| 1        | DC Invalidates DC (aliasing)                                                                   |
| 0        | DC Invalidates IC (modification of cached instructions, or of data located too close to code). |

### PMCx076 CPU Clocks not Halted

#### [PERF\\_CTL\[2:0\]](#).

The number of clocks that the CPU is not in a halted state (due to STPCLK or a HLT instruction). Note: this event allows system idle time to be automatically factored out from IPC (or CPI) measurements, providing the OS halts the CPU when going idle. If the OS goes into an idle loop rather than halting, such calculations are influenced by the IPC of the idle loop.

### PMCx07D Requests to L2 Cache

[PERF\\_CTL\[2:0\]](#). The number of requests to the L2 cache for Icache or Dcache fills, or page table lookups for the TLB. These events reflect only read requests to the L2; writes to the L2 are indicated by [PMCx07E](#). See [PMCx081](#), [PMCx082](#), [PMCx083](#), [PMCx041](#), [PMCx042](#), [PMCx043](#).

| UnitMask | Description                 |
|----------|-----------------------------|
| 7        | Reserved.                   |
| 6        | L2 cache prefetcher request |
| 5        | Reserved.                   |
| 4        | Canceled request            |
| 3        | NB probe request            |
| 2        | TLB fill (page table walks) |
| 1        | DC fill                     |
| 0        | IC fill                     |

### PMCx07E L2 Cache Misses

[PERF\\_CTL\[2:0\]](#). The number of requests that miss in the L2 cache. This may include some amount of speculative activity. The IC-fill-miss and DC-fill-miss events tend to mirror the Icache and Dcache refill-from-system [PMCx083](#) and [PMCx043](#), and tend to include more speculative activity than those events.

| UnitMask | Description                 |
|----------|-----------------------------|
| 7:6      | Reserved.                   |
| 5        | Reserved.                   |
| 4        | L2 Cache Prefetcher request |

|   |                                                                               |
|---|-------------------------------------------------------------------------------|
| 3 | Reserved.                                                                     |
| 2 | TLB page table walk                                                           |
| 1 | DC fill (includes possible replays, whereas <a href="#">PMCx041</a> does not) |
| 0 | IC fill                                                                       |

### PMCx07F L2 Fill/Writeback

[PERF\\_CTL\[2:0\]](#). Each increment represents a 64 B cache line transfer.

| UnitMask | Description                                                                                                                                                                        |
|----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 7:3      | Reserved.                                                                                                                                                                          |
| 2        | <b>L2CleanWritebacks</b> . L2 Clean Writebacks to system                                                                                                                           |
| 1        | <b>L2Writebacks</b> . L2 Writebacks to system (Clean and Dirty)                                                                                                                    |
| 0        | <b>L2Fills</b> . L2 fills from system. Note: Fills for non-temporal software prefetch and WP-memtype fills also are counted in this event even though they don't get cached in L2. |

### PMCx165 Page Splintering

[PERF\\_CTL\[2:0\]](#). Counts the number of TLB reloads where a large page is installed into the TLB as a smaller page size.

| UnitMask | Description                                                                      |
|----------|----------------------------------------------------------------------------------|
| 7:3      | Reserved.                                                                        |
| 2        | Host page size is larger than the guest page size.                               |
| 1        | Splintering due to MTRRs, IORRs, APIC, TOMs or other special address region.     |
| 0        | Guest page size is larger than the host page size when nested paging is enabled. |

### PMCx16C L2 Prefetcher Trigger Events

[PERF\\_CTL\[2:0\]](#).

| UnitMask | Description                       |
|----------|-----------------------------------|
| 7:2      | Reserved.                         |
| 1        | Store L1 miss seen by prefetcher. |
| 0        | Load L1 miss seen by prefetcher.  |

### 3.23.5 PMCx[1:0][9F:80] Events (IC)

Note: All instruction cache events are speculative events unless specified otherwise.

### PMCx080 Instruction Cache Fetches

[PERF\\_CTL\[2:0\]](#).

The number of successful instruction cache accesses by the instruction fetcher that result in data being sent to the decoder. Each access is an aligned 32 byte read, from which a varying number of instructions may be decoded.

**PMCx081 Instruction Cache Misses**[PERF\\_CTL\[2:0\]](#).

The number of instruction fetches and prefetch requests that miss in the instruction cache. This is typically equal to or very close to the sum of events 82h and 83h. Each miss results in a 64-byte cache line refill.

**PMCx082 Instruction Cache Refills from L2**[PERF\\_CTL\[2:0\]](#).

The number of instruction cache refills satisfied from the L2 cache. Each increment represents one 64-byte cache line transfer.

**PMCx083 Instruction Cache Refills from System**[PERF\\_CTL\[2:0\]](#).

The number of instruction cache refills from system memory (or another cache). Each increment represents one 64-byte cache line transfer.

**PMCx084 L1 ITLB Miss, L2 ITLB Hit**[PERF\\_CTL\[2:0\]](#).

The number of instruction fetches that miss in the L1 ITLB but hit in the L2 ITLB.

**PMCx085 L1 ITLB Miss, L2 ITLB Miss**[PERF\\_CTL\[2:0\]](#). The number of instruction fetches that miss in both the L1 and L2 TLBs.

| UnitMask | Description                         |
|----------|-------------------------------------|
| 7:3      | Reserved.                           |
| 2        | Instruction fetches to a 1 GB page. |
| 1        | Instruction fetches to a 2 MB page. |
| 0        | Instruction fetches to a 4 KB page. |

**PMCx086 Pipeline Restart Due to Instruction Stream Probe**

[PERF\\_CTL\[2:0\]](#). The number of pipeline restarts caused by invalidating probes that hit on the instruction stream currently being executed. This would happen if the active instruction stream was being modified by another processor in an MP system - typically a highly unlikely event.

**PMCx087 Instruction Fetch Stall**

[PERF\\_CTL\[2:0\]](#). The number of cycles the instruction fetcher is stalled for the core. This may be for a variety of reasons such as branch predictor updates, unconditional branch bubbles, far jumps and cache misses, instruction fetching for the other core while instruction fetch for this core is stalled, among others. May be overlapped by instruction dispatch stalls or instruction execution, such that these stalls don't necessarily impact performance.

**PMCx088 Return Stack Hits****PERF\_CTL[2:0].**

The number of near return instructions (RET or RET Iw) that get their return address from the return address stack (i.e. where the stack has not gone empty) for the core. This may include cases where the address is incorrect (return mispredicts). This may also include speculatively executed false-path returns. Return mispredicts are typically caused by the return address stack underflowing, however they may also be caused by an imbalance in calls vs. returns, such as doing a call but then popping the return address off the stack.

This event cannot be reliably compared with events C9h and CAh (such as to calculate percentage of return mispredicts due to an empty return address stack), since it may include speculatively executed false-path returns that are not included in those retire-time events.

**PMCx089 Return Stack Overflows**

**PERF\_CTL[2:0].** The number of (near) call instructions that cause the return address stack to overflow. When this happens, the oldest entry is discarded. This count may include speculatively executed calls.

**PMCx08B Instruction Cache Victims**

**PERF\_CTL[2:0].** The number of cachelines evicted from the instruction cache that cause an L2 write due to changed predecode (start bits); the L2 write due to changed predecode doesn't write the instruction bytes. This event does not count IC evictions with unchanged predecode, which are silently dropped without an L2 write. This event is not core specific and for either core counts the IC victims caused by both cores of the compute unit.

**PMCx08C Instruction Cache Lines Invalidated**

**PERF\_CTL[2:0].** The number of instruction cache lines invalidated. A non-SMC event is CMC (cross modifying code), either from the other core of the compute unit or another compute compute unit.

| UnitMask | Description                                                       |
|----------|-------------------------------------------------------------------|
| 7:4      | Reserved.                                                         |
| 3        | SMC invalidating probe that hit on in-flight instructions.        |
| 2        | SMC invalidating probe that missed on in-flight instructions.     |
| 1        | Non-SMC invalidating probe that hit on in-flight instructions.    |
| 0        | Non-SMC invalidating probe that missed on in-flight instructions. |

**PMCx099 ITLB Reloads**

**PERF\_CTL[2:0].** The number of ITLB reload requests.

**PMCx09A ITLB Reloads Aborted**

**PERF\_CTL[2:0].** The number of ITLB reloads aborted.

### PMCx186 Uops Dispatched From Decoder

**PERF\_CTL[2:0]**. Counts uops that are dispatched from the decoder each cycle. The number of events logged per cycle can vary from 0 to 4. Note that when microcode dispatches between 1 to 4 uops in a cycle then 4 uops are counted in that cycle.

| UnitMask | Description                                                                                                                                                                                                                                   |
|----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 7:1      | Reserved.                                                                                                                                                                                                                                     |
| 0        | <b>UopsDispatched: Uops Dispatched From Decoder.</b><br><b>AllOps.</b> Ops dispatched from the decoder.<br><div> <div>Bits</div> <div>Description</div> </div> <div> <div>0h</div> <div>AllOps: Ops dispatched from the decoder.</div> </div> |

### 3.23.6 PMCx[1,0][DF:C0] Events (EX, DE)

#### PMCx0C0 Retired Instructions

**PERF\_CTL[5:0]**. The number of instructions retired (execution completed and architectural state updated). This count includes exceptions and interrupts - each exception or interrupt is counted as one instruction.

#### PMCx0C1 Retired uops

**PERF\_CTL[5:0]**. The number of micro-ops retired. This includes all processor activity (instructions, exceptions, interrupts, microcode assists, etc.). The number of events logged per cycle can vary from 0 to 4.

#### PMCx0C2 Retired Branch Instructions

**PERF\_CTL[5:0]**. The number of branch instructions retired. This includes all types of architectural control flow changes, including exceptions and interrupts.

#### PMCx0C3 Retired Mispredicted Branch Instructions

**PERF\_CTL[5:0]**. The number of branch instructions retired, of any type, that were not correctly predicted. This includes those for which prediction is not attempted (far control transfers, exceptions and interrupts).

#### PMCx0C4 Retired Taken Branch Instructions

**PERF\_CTL[5:0]**. The number of taken branches that were retired. This includes all types of architectural control flow changes, including exceptions and interrupts.

#### PMCx0C5 Retired Taken Branch Instructions Mispredicted

**PERF\_CTL[5:0]**. The number of retired taken branch instructions that were mispredicted.

#### PMCx0C6 Retired Far Control Transfers

**PERF\_CTL[5:0]**. The number of far control transfers retired including far call/jump/return, IRET, SYSCALL and SYSRET, plus exceptions and interrupts. Far control transfers are not subject to branch prediction.

**PMCx0C7 Retired Branch Resyncs**

[PERF\\_CTL\[5:0\]](#). The number of resync branches. These reflect pipeline restarts due to certain microcode assists and events such as writes to the active instruction stream, among other things. Each occurrence reflects a restart penalty similar to a branch mispredict. This is relatively rare.

**PMCx0C8 Retired Near Returns**

[PERF\\_CTL\[5:0\]](#). The number of near return instructions (RET or RET Iw) retired.

**PMCx0C9 Retired Near Returns Mispredicted**

[PERF\\_CTL\[5:0\]](#). The number of near returns retired that were not correctly predicted by the return address predictor. Each such mispredict incurs the same penalty as a mispredicted conditional branch instruction.

**PMCx0CA Retired Mispredicted Taken Branch Instructions due to Target Mismatch**

[PERF\\_CTL\[5:0\]](#). The number of indirect branch instructions retired where the target address was not correctly predicted.

**PMCx0CB Retired MMX/FP Instructions**

[PERF\\_CTL\[5:0\]](#). The number of MMX, SSE or x87 instructions retired. The UnitMask allows the selection of the individual classes of instructions as given in the table. Each increment represents one complete instruction. Since this event includes non-numeric instructions it is not suitable for measuring MFLOPS.

| UnitMask | Description                                                                      |
|----------|----------------------------------------------------------------------------------|
| 7:3      | Reserved.                                                                        |
| 2        | SSE instructions (SSE, SSE2, SSE3, SSSE3, SSE4A, SSE4.1, SSE4.2, AVX, XOP, FMA4) |
| 1        | MMX™ instructions.                                                               |
| 0        | x87 instructions.                                                                |

**PMCx0CD Interrupts-Masked Cycles**

[PERF\\_CTL\[5:0\]](#). The number of cycles where interrupts are masked (EFLAGS.IF = 0). Using edge-counting with this event gives the number of times IF is cleared; dividing the cycle-count value by this value gives the average length of time that interrupts are disabled on each instance. Compare the edge count with [PMCx0CF](#) to determine how often interrupts are disabled for interrupt handling vs. other reasons (e.g. critical sections).

**PMCx0CE Interrupts-Masked Cycles with Interrupt Pending**

[PERF\\_CTL\[5:0\]](#). The number of cycles where interrupts are masked (EFLAGS.IF = 0) and an interrupt is pending. Using edge-counting with this event and comparing the resulting count with the edge count for [PMCx0CD](#) gives the proportion of interrupts for which handling is delayed due to prior interrupts being serviced, critical sections, etc. The cycle count value gives the total amount of time for such delays. The cycle count divided by the edge count gives the average length of each such delay.

**PMCx0CF Interrupts Taken**

---

[PERF\\_CTL\[5:0\]](#). The number of hardware interrupts taken. This does not include software interrupts (INT n instruction).

**PMCx0D0 Decoder Empty**

---

[PERF\\_CTL\[2:0\]](#). The number of cycles where the decoder has nothing to dispatch (typically waiting on an instruction fetch that missed the Icache, or for the target fetch after a branch mispredict).

**PMCx0D1 Dispatch Stalls**

---

[PERF\\_CTL\[2:0\]](#). The number of cycles where the decoder is stalled for any reason (has one or more instructions ready but can't dispatch them due to resource limitations in execution). This event counts even when dispatch selects the other core of the compute-unit. This is the combined effect of events [PMCx0D3](#) to [PMCx0D9](#), some of which may overlap; this event reflects the net stall cycles. The more common stall conditions (events [PMCx0D5](#), [PMCx0D6](#), [PMCx0D7](#), [PMCx0D8](#)) may overlap considerably. The occurrence of these stalls is highly dependent on the nature of the code being executed (instruction mix, memory reference patterns, etc.).

**PMCx0D3 Microsequencer Stall due to Serialization**

---

[PERF\\_CTL\[2:0\]](#). The number of cycles the microsequencer is stalled due to a serializing operation, which waits for the execution pipeline to drain. Relatively rare; mainly associated with system instructions. See [PMCx0D1](#).

**PMCx0D5 Dispatch Stall for Instruction Retire Queue Full**

---

[PERF\\_CTL\[2:0\]](#). The number of cycles the decoder is stalled because the instruction retire Q is full. This event counts even when dispatch selects the other core of the compute-unit. May occur simultaneously with certain other stall conditions; see [PMCx0D1](#).

**PMCx0D6 Dispatch Stall for Integer Scheduler Queue Full**

---

[PERF\\_CTL\[2:0\]](#). The number of cycles the decoder is stalled because a required integer unit scheduler queue is full. This event counts even when dispatch selects the other core of the compute-unit. May occur simultaneously with certain other stall conditions; see [PMCx0D1](#).

**PMCx0D7 Dispatch Stall for FP Scheduler Queue Full**

---

[PERF\\_CTL\[2:0\]](#). The number of cycles the decoder is stalled because the scheduler for the Floating Point scheduler queue is full. This event counts even when dispatch selects the other core of the compute-unit. This condition can be caused by a lack of parallelism in FP-intensive code, or by cache misses on FP operand loads (which could also show up as [PMCx0D8](#) instead, depending on the nature of the instruction sequences). May occur simultaneously with certain other stall conditions; see [PMCx0D1](#).

**PMCx0D8 Dispatch Stall for LDQ Full**

---

[PERF\\_CTL\[2:0\]](#). The number of cycles the decoder is stalled because the load queue is full. This event counts

even when dispatch selects the other core of the compute-unit. This generally occurs due to heavy cache miss activity. May occur simultaneously with certain other stall conditions; see [PMCx0D1](#).

### PMCx0D9 Microsequencer Stall Waiting for All Quiet

[PERF\\_CTL\[2:0\]](#). The number of cycles the microsequencer is stalled waiting for all outstanding requests to the system to be resolved. Relatively rare; associated with certain system instructions and types of interrupts. May partially overlap certain other stall conditions; see [PMCx0D1](#).

### PMCx0DB FPU Exceptions

[PERF\\_CTL\[5:0\]](#). The number of floating point unit exceptions for microcode assists. The UnitMask may be used to isolate specific types of exceptions.

| UnitMask | Description       |
|----------|-------------------|
| 7:5      | Reserved.         |
| 4        | Bypass faults     |
| 3        | Ext2Int faults    |
| 2        | Int2Ext faults    |
| 1        | Total microtraps  |
| 0        | Total microfaults |

### PMCx0D[F:C] DR[3:0] Breakpoint Matches

[PERF\\_CTL\[5:0\]](#).

Table 257: [Register Mapping](#) for [PMCx0D\[F:C\]](#)

| Register | Function |
|----------|----------|
| PMCx0DC  | DR0      |
| PMCx0DD  | DR1      |
| PMCx0DE  | DR2      |
| PMCx0DF  | DR3      |

The number of matches on the address in breakpoint register DR[3:0], per the breakpoint type specified in DR7. Matches occur if the access becomes non-speculative, but not necessarily retired. Each instruction breakpoint match incurs an overhead of about 120 cycles; load/store breakpoint matches do not incur any overhead.

### PMCx1C0 Retired x87 Floating Point Operations

[PERF\\_CTL\[5:3\]](#). The number of x87 floating point ops that have retired.

| UnitMask | Description                |
|----------|----------------------------|
| 7:3      | Reserved.                  |
| 2        | Divide and square root ops |



|   |                  |
|---|------------------|
| 1 | Multiply ops     |
| 0 | Add/subtract ops |

### PMCx1CF Tagged IBS Ops

[PERF\\_CTL\[5:0\]](#).

| UnitMask | Description                                                                                            |
|----------|--------------------------------------------------------------------------------------------------------|
| 7:3      | Reserved.                                                                                              |
| 2        | Number of times an op could not be tagged by IBS because of a previous tagged op that has not retired. |
| 1        | Number of ops tagged by IBS that retired.                                                              |
| 0        | Number of ops tagged by IBS.                                                                           |

### PMCx1D0 Retired Fused Branch Instructions

[PERF\\_CTL\[5:0\]](#). Implemented by EX. The number of fused retired branch instructions retired per cycle. The number of events logged per cycle can vary from 0 to 3.

### PMCx1D8 Dispatch Stall for STQ Full

[PERF\\_CTL\[5:0\]](#). The number of cycles the decoder is stalled because the store queue is full. This event counts even when dispatch selects the other core of the compute-unit. This generally occurs due to heavy cache miss activity. May occur simultaneously with certain other stall conditions.

### PMCx1DD Cycles Without Dispatch Due To Integer PRF Tokens

[PERF\\_CTL\[2:0\]](#). The number of cycles a core has valid ops for dispatch and one of the reasons for a dispatch stall is the absence of sufficient integer PRF tokens. This event counts even when dispatch selects the other core of the compute-unit.

### PMCx1DE Cycles Without Dispatch Due to FP PRF Tokens

[PERF\\_CTL\[2:0\]](#). The number of cycles a core has valid ops for dispatch and one of the reasons for a dispatch stall is the absence of sufficient FP PRF tokens. This event requires that the other core of the compute unit is in the Halt state. This event counts even when dispatch selects the other core of the compute-unit.

### PMCx1DF FP Dispatch Contention

[PERF\\_CTL\[2:0\]](#). Cycles in which there is contention between the two threads for FP dispatch.

| UnitMask | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |      |             |     |                                                                                                 |     |                                                                                             |     |                                                                                             |     |                                                                                         |
|----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|-----|-------------------------------------------------------------------------------------------------|-----|---------------------------------------------------------------------------------------------|-----|---------------------------------------------------------------------------------------------|-----|-----------------------------------------------------------------------------------------|
| 7:2      | Reserved.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |      |             |     |                                                                                                 |     |                                                                                             |     |                                                                                             |     |                                                                                         |
| 1:0      | <b>ContentionSel.</b><br><table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>00b</td><td>The other selected thread did not dispatch; this not selected thread could not have dispatched.</td></tr> <tr> <td>01b</td><td>The other selected thread did not dispatch; this not selected thread could have dispatched.</td></tr> <tr> <td>10b</td><td>The other selected thread did dispatch; this not selected thread could not have dispatched.</td></tr> <tr> <td>11b</td><td>The other selected thread did dispatch; this not selected thread could have dispatched.</td></tr> </table> | Bits | Description | 00b | The other selected thread did not dispatch; this not selected thread could not have dispatched. | 01b | The other selected thread did not dispatch; this not selected thread could have dispatched. | 10b | The other selected thread did dispatch; this not selected thread could not have dispatched. | 11b | The other selected thread did dispatch; this not selected thread could have dispatched. |
| Bits     | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |      |             |     |                                                                                                 |     |                                                                                             |     |                                                                                             |     |                                                                                         |
| 00b      | The other selected thread did not dispatch; this not selected thread could not have dispatched.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |      |             |     |                                                                                                 |     |                                                                                             |     |                                                                                             |     |                                                                                         |
| 01b      | The other selected thread did not dispatch; this not selected thread could have dispatched.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |      |             |     |                                                                                                 |     |                                                                                             |     |                                                                                             |     |                                                                                         |
| 10b      | The other selected thread did dispatch; this not selected thread could not have dispatched.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |      |             |     |                                                                                                 |     |                                                                                             |     |                                                                                             |     |                                                                                         |
| 11b      | The other selected thread did dispatch; this not selected thread could have dispatched.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |      |             |     |                                                                                                 |     |                                                                                             |     |                                                                                             |     |                                                                                         |

### 3.24 NB Performance Counter Events

This section provides the performance counter events that may be selected through [MSRC001\\_024\[6,4,2,0\]\[EventSelect,UnitMask\]](#). See that register and [MSRC001\\_024\[7,5,3,1\]](#) [Northbridge Performance Event Counter (NB\_PERF\_CTR[3:0])].

#### 3.24.1 PMCx0E[7:4] Events (Memory Controller)

##### NBPMCx0E4 Memory Controller Bypass Counter Saturation

| UnitMask  | Description                                                                                                                                                                                                                                 |      |             |      |                        |      |                        |           |          |
|-----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------------|------|------------------------|------|------------------------|-----------|----------|
| 7:6       | Reserved.                                                                                                                                                                                                                                   |      |             |      |                        |      |                        |           |          |
| 5         | DCQ Bypass Saturated. The DCT is selected by the field NBPMCx0E4[4:2].                                                                                                                                                                      |      |             |      |                        |      |                        |           |          |
| 4:2       | Select DCQ bypass: <table> <tr> <th>Bits</th><th>Description</th></tr> <tr> <td>000b</td><td>Select DCT0 DCQ bypass</td></tr> <tr> <td>001b</td><td>Select DCT1 DCQ bypass</td></tr> <tr> <td>111b-010b</td><td>Reserved</td></tr> </table> | Bits | Description | 000b | Select DCT0 DCQ bypass | 001b | Select DCT1 DCQ bypass | 111b-010b | Reserved |
| Bits      | Description                                                                                                                                                                                                                                 |      |             |      |                        |      |                        |           |          |
| 000b      | Select DCT0 DCQ bypass                                                                                                                                                                                                                      |      |             |      |                        |      |                        |           |          |
| 001b      | Select DCT1 DCQ bypass                                                                                                                                                                                                                      |      |             |      |                        |      |                        |           |          |
| 111b-010b | Reserved                                                                                                                                                                                                                                    |      |             |      |                        |      |                        |           |          |
| 1         | Memory controller medium priority bypass                                                                                                                                                                                                    |      |             |      |                        |      |                        |           |          |
| 0         | Memory controller high priority bypass                                                                                                                                                                                                      |      |             |      |                        |      |                        |           |          |

#### 3.24.2 PMCx0E[F:8] Events (Crossbar)

##### NBPMCx0E8 Thermal Status

| UnitMask | Description                              |
|----------|------------------------------------------|
| 7        | Reserved                                 |
| 6        | Number of clocks HTC P-state is active   |
| 5        | Number of clocks HTC P-state is inactive |
| 4        | Reserved.                                |
| 3        | Reserved.                                |

|     |                                               |
|-----|-----------------------------------------------|
| 2   | Number of times the HTC trip point is crossed |
| 1:0 | Reserved                                      |

### NBPMCx0E9 CPU/IO Requests to Memory/IO

These events reflect request flow between units and nodes, as selected by the UnitMask. The UnitMask is divided into two fields: request type (CPU or IO access to IO or Memory) and source/target location (local vs. remote). One or more requests types must be enabled via bits 3:0, and at least one source and one target location must be selected via bits 7:4. Each event reflects a request of the selected type(s) going from the selected source(s) to the selected target(s).

Not all possible paths are supported. The following table shows the UnitMask values that are valid for each request type:

| Source/Target    | CPU to Mem | CPU to IO | IO to Mem | IO to IO |
|------------------|------------|-----------|-----------|----------|
| Local -> Local   | A8h        | A4h       | A2h       | A1h      |
| Local -> Remote  | 98h        | 94h       | 92h       | 91h      |
| Remote -> Local  | -          | 64h       | -         | 61h      |
| Remote -> Remote | -          | -         | -         | -        |

Any of the mask values shown may be logically ORed to combine the events. For instance, local CPU requests to both local and remote nodes would be  $A8h \mid 98h = B8h$ . Any CPU to any IO would be  $A4h \mid 94h \mid 64h = F4h$  (but remote CPU to remote IO requests would not be included).

Note: It is not possible to tell from these events how much data is going in which direction, as there is no distinction between reads and writes. Also, particularly for IO, the requests may be for varying amounts of data, anywhere from one to sixty-four bytes. For a direct measure of the amount and direction of data flowing between nodes, use events F6h, F7h and F8h.

| UnitMask | Description      |
|----------|------------------|
| 7        | From local node  |
| 6        | From remote node |
| 5        | To local node    |
| 4        | To remote node   |
| 3        | CPU to Mem       |
| 2        | CPU to IO        |
| 1        | IO to Mem        |
| 0        | IO to IO         |

### NBPMCx0EA Cache Block Commands

The number of requests made to the system for cache line transfers or coherency state changes, by request type. Each increment represents one cache line transfer, except for Change-to-Dirty. If a Change-to-Dirty request hits on a line in another processor's cache that's in the Owned state, it causes a cache line transfer, otherwise there is no data transfer associated with Change-to-Dirty requests.

| UnitMask | Description                                                   |
|----------|---------------------------------------------------------------|
| 7:6      | Reserved.                                                     |
| 5        | Change-to-Dirty (first store to clean block already in cache) |
| 4        | Read Block Modified (Dcache store miss refill)                |
| 3        | Read Block Shared (Icache refill)                             |
| 2        | Read Block (Dcache load miss refill)                          |
| 1        | Reserved.                                                     |
| 0        | Victim Block (Writeback)                                      |

### NBPMCx0EB Sized Commands

The number of Sized Read/Write commands handled by the System Request Interface (local processor and hostbridge interface to the system). These commands may originate from the processor or hostbridge. Typical uses of the various Sized Read/Write commands are given in the UnitMask table. See [NBPMCx0EC](#), which provides a separate measure of Hostbridge accesses.

| UnitMask | Description                                                                                                                                    |
|----------|------------------------------------------------------------------------------------------------------------------------------------------------|
| 7:6      | Reserved.                                                                                                                                      |
| 5        | SzRd DW (1-16 DWORDs). Typical Usage: Block-oriented DMA reads, typically cache-line size.                                                     |
| 4        | SzRd Byte (4 bytes). Typical Usage: Legacy or mapped IO.                                                                                       |
| 3        | Posted SzWr DW (1-16 DWORDs). Typical Usage: Block-oriented DMA writes, often cache-line sized; also processor Write Combining buffer flushes. |
| 2        | Posted SzWr Byte (1-32 bytes). Typical Usage: Sub-cache-line DMA writes, size varies; also flushes of partially-filled Write Combining buffer. |
| 1        | Non-Posted SzWr DW (1-16 DWORDs). Typical Usage: Legacy or mapped IO, typically 1 DWORD.                                                       |
| 0        | Non-Posted SzWr Byte (1-32 bytes). Typical Usage: Legacy or mapped IO, typically 1-4 bytes.                                                    |

### NBPMCx0EC Probe Responses and Upstream Requests

This covers two unrelated sets of events: cache probe results, and requests received by the hostbridge from devices on non-coherent links.

**Probe results:** These events reflect the results of probes sent from a memory controller to local caches. They provide an indication of the degree data and code is shared between processors (or moved between processors due to process migration). The dirty-hit events indicate the transfer of a 64-byte cache line to the requestor (for a read or cache refill) or the target memory (for a write). The system bandwidth used by these, in terms of bytes per unit of time, may be calculated as 64 times the event count, divided by the elapsed time. Sized writes to memory that cover a full cache line do not incur this cache line transfer -- they simply invalidate the line and are reported as clean hits. Cache line transfers occur for Change2Dirty requests that hit cache lines in the Owned state. (Such cache lines are counted as Modified-state refills for [PMCx06C](#), System Read Responses.)

**Upstream requests:** The upstream read and write events reflect requests originating from a device on a local IO link.

| UnitMask | Description                                                                     |
|----------|---------------------------------------------------------------------------------|
| 7        | Upstream non-ISOC writes                                                        |
| 6        | Upstream ISOC writes                                                            |
| 5        | Upstream non-display refresh reads                                              |
| 4        | Upstream display refresh/ISOC reads                                             |
| 3        | Probe hit dirty with memory cancel (probed by DMA read or cache refill request) |
| 2        | Probe hit dirty without memory cancel (probed by Sized Write or Change2Dirty)   |
| 1        | Probe hit clean                                                                 |
| 0        | Probe miss                                                                      |

### 3.24.3 PMCx0F[F:0] Events (Crossbar)

### 3.24.4 NBPMCx1E[F:0] Events (Crossbar)

#### NBPMCx1E0 CPU to DRAM Requests to Target Node

This event counts all DRAM reads and writes generated by cores on the local node to the targeted node in the coherent fabric. This counter can be used to observe processor data affinity in NUMA aware operating systems.

| UnitMask | Description               |
|----------|---------------------------|
| 7        | From Local node to Node 7 |
| 6        | From Local node to Node 6 |
| 5        | From Local node to Node 5 |
| 4        | From Local node to Node 4 |
| 3        | From Local node to Node 3 |
| 2        | From Local node to Node 2 |
| 1        | From Local node to Node 1 |
| 0        | From Local node to Node 0 |

#### NBPMCx1E1 IO to DRAM Requests to Target Node

This event counts all DRAM reads and writes generated by IO devices attached to the IO links of the local node the targeted node in the coherent fabric. This counter can be used to observe IO device data affinity in NUMA aware operating systems.

| UnitMask | Description               |
|----------|---------------------------|
| 7        | From Local node to Node 7 |
| 6        | From Local node to Node 6 |
| 5        | From Local node to Node 5 |
| 4        | From Local node to Node 4 |
| 3        | From Local node to Node 3 |
| 2        | From Local node to Node 2 |

|   |                           |
|---|---------------------------|
| 1 | From Local node to Node 1 |
| 0 | From Local node to Node 0 |

### NBPMCx1E2 CPU Read Command Latency to Target Node 0-3

This event counts the number of NB clocks from when the targeted command is received in the NB to when the targeted command completes. This event only tracks one outstanding command at a time. To determine latency between the local node and a remote node set UnitMask[7:4] to select the node and UnitMask[3:0] to select the read command type. The count returned by the counter should be divided by the count returned by [NBPMCx1E3](#) to determine the average latency for the command type.

| UnitMask | Description               |
|----------|---------------------------|
| 7        | From Local node to Node 3 |
| 6        | From Local node to Node 2 |
| 5        | From Local node to Node 1 |
| 4        | From Local node to Node 0 |
| 3        | Change-to-Dirty           |
| 2        | Read block modified       |
| 1        | Read block shared         |
| 0        | Read block                |

### NBPMCx1E3 CPU Read Command Requests to Target Node 0-3

This event counts the number of requests that a latency measurement is made for using [NBPMCx1E2](#). To determine the number of commands that a latency measurement are made for between the local node and a remote node set UnitMask[7:4] to select the node and UnitMask[3:0] to select the read command type.

| UnitMask | Description               |
|----------|---------------------------|
| 7        | From Local node to Node 3 |
| 6        | From Local node to Node 2 |
| 5        | From Local node to Node 1 |
| 4        | From Local node to Node 0 |
| 3        | Change-to-Dirty           |
| 2        | Read block modified       |
| 1        | Read block shared         |
| 0        | Read block                |

### NBPMCx1E4 CPU Read Command Latency to Target Node 4-7

This event counts the number of NB clocks from when the targeted command is received in the NB to when the targeted command completes. This event only tracks one outstanding command at a time. To determine latency between the local node and a remote node set UnitMask[7:4] to select the node and UnitMask[3:0] to select the read command type. The count returned by the counter should be divided by the count returned by [NBPMCx1E5](#) to determine the average latency for the command type.

| UnitMask | Description               |
|----------|---------------------------|
| 7        | From Local node to Node 7 |
| 6        | From Local node to Node 6 |
| 5        | From Local node to Node 5 |
| 4        | From Local node to Node 4 |
| 3        | Change-to-Dirty           |
| 2        | Read block modified       |
| 1        | Read block shared         |
| 0        | Read block                |

#### **NBPMCx1E5 CPU Read Command Requests to Target Node 4-7**

This event counts the number of requests that a latency measurement is made for using [NBPMCx1E4](#). To determine the number of commands that a latency measurement are made for between the local node and a remote node set UnitMask[7:4] to select the node and UnitMask[3:0] to select the read command type.

| UnitMask | Description               |
|----------|---------------------------|
| 7        | From Local node to Node 7 |
| 6        | From Local node to Node 6 |
| 5        | From Local node to Node 5 |
| 4        | From Local node to Node 4 |
| 3        | Change-to-Dirty           |
| 2        | Read block modified       |
| 1        | Read block shared         |
| 0        | Read block                |

#### **NBPMCx1E6 CPU Command Latency to Target Node 0-3/4-7**

This event counts the number of NB clocks from when the targeted command is received in the NB to when the targeted command completes. This event only tracks one outstanding command at a time. To determine latency between the local node and a remote node set UnitMask[7:4] to select the node, UnitMask[3] to select the node group and UnitMask[3:0] to select the command type. The count returned by the counter should be divided by the count returned by [NBPMCx1E7](#) to determine the average latency for the command type.

| UnitMask | Description                                   |
|----------|-----------------------------------------------|
| 7        | From Local node to Node 3/7                   |
| 6        | From Local node to Node 2/6                   |
| 5        | From Local node to Node 1/5                   |
| 4        | From Local node to Node 0/4                   |
| 3        | Node Group Select. 0=Nodes 0-3. 1= Nodes 4-7. |
| 2        | Victim Block                                  |
| 1        | Write Sized                                   |
| 0        | Read Sized                                    |

### NBPMCx1E7 CPU Requests to Target Node 0-3/4-7

This event counts the number of requests that a latency measurement is made for using [NBPMCx1E6](#). To determine the number of commands that a latency measurement are made for between the local node and a remote node set UnitMask[7:4] to select the node, UnitMask[3] to select the node group and UnitMask[3:0] to select the command type.

| UnitMask | Description                                   |
|----------|-----------------------------------------------|
| 7        | From Local node to Node 3/7                   |
| 6        | From Local node to Node 2/6                   |
| 5        | From Local node to Node 1/5                   |
| 4        | From Local node to Node 0/4                   |
| 3        | Node Group Select. 0=Nodes 0-3. 1= Nodes 4-7. |
| 2        | Victim Block                                  |
| 1        | Write Sized                                   |
| 0        | Read Sized                                    |

### NBPMCx1EB Request Cache Status 1

The probe response type for RdBlkM or ChgToDirty request type.

| UnitMask | Description                     |
|----------|---------------------------------|
| 7        | Track Cache Stat for RdBlkM     |
| 6        | Track Cache Stat for ChgToDirty |
| 5        | Directed Probe                  |
| 4        | Probe Miss                      |
| 3        | Probe Hit M                     |
| 2        | Probe Hit MuW or O              |
| 1        | Probe Hit E                     |
| 0        | Probe Hit S                     |

### 3.24.5 NBPMCx1F[F:0] Events (Memory Controller, Crossbar)

#### NBPMCx1F0 Memory Controller Requests

Read/Write requests: The read/write request events reflect the total number of commands sent to the DRAM controller.

Sized Read/Write activity: The Sized Read/Write events reflect 32- or 64-byte transfers (as opposed to other sizes which could be anywhere between 1 and 64 bytes), from either the processor or the Hostbridge (on any node in an MP system). Such accesses from the processor would be due only to write combining buffer flushes, where 32-byte accesses would reflect flushes of partially-filled buffers. [PMCx065](#) provides a count of sized write requests associated with WC buffer flushes; comparing that with counts for these events (providing there is very little Hostbridge activity at the same time) gives an indication of how efficiently the write combining buffers are being used. [PMCx065](#) may also be useful in factoring out WC flushes when comparing these events with the Upstream Requests component of [PMCx06C](#).



| UnitMask | Description                                                                |
|----------|----------------------------------------------------------------------------|
| 7        | Read requests sent to the DCT while writes requests are pending in the DCT |
| 6        | 64 Byte Sized Reads                                                        |
| 5        | 32 Bytes Sized Reads                                                       |
| 4        | 64 Bytes Sized Writes                                                      |
| 3        | 32 Bytes Sized Writes                                                      |
| 2        | Prefetch requests sent to the DCT                                          |
| 1        | Read requests (including prefetch requests) sent to the DCT                |
| 0        | Write requests sent to the DCT                                             |

### NBPMCx3EC DRAM Accesses

The number of memory accesses performed by the local DRAM controller. UnitMask[7:0] may be used to isolate the different DRAM page access cases. Page miss cases incur an extra latency to open a page; page conflict cases incur both a page-close as well as page-open penalties. These penalties may be overlapped by DRAM accesses for other requests and don't necessarily represent lost DRAM bandwidth. The associated penalties are as follows:

Page miss:  $T_{rd}$  (DRAM RAS-to-CAS delay)

Page conflict:  $T_{rp} + T_{rd}$  (DRAM row-precharge time plus RAS-to-CAS delay)

Each DRAM access represents one 64-byte block of data transferred if the DRAM is configured for 64-byte granularity, or one 32-byte block if the DRAM is configured for 32-byte granularity. (The latter is only applicable to single-channel DRAM systems, which may be configured either way.)

| UnitMask | Description        |
|----------|--------------------|
| 7:6      | Reserved.          |
| 5        | DCT1 Page Conflict |
| 4        | DCT1 Page Miss     |
| 3        | DCT1 Page hit      |
| 2        | DCT0 Page Conflict |
| 1        | DCT0 Page Miss     |
| 0        | DCT0 Page hit      |

### NBPMCx3ED DRAM Controller Page Table Overflows

The number of page table overflows in the local DRAM controller. This table maintains information about which DRAM pages are open. An overflow occurs when a request for a new page arrives when the maximum number of pages are already open. Each occurrence reflects an access latency penalty equivalent to a page conflict.

| UnitMask | Description |
|----------|-------------|
| 7:2      | Reserved.   |

|   |                          |
|---|--------------------------|
| 1 | DCT1 Page Table Overflow |
| 0 | DCT0 Page Table Overflow |

### NBPMCx3EE Memory Controller DRAM Command Slots Missed

| UnitMask | Description                            |
|----------|----------------------------------------|
| 7:2      | Reserved.                              |
| 1        | DCT1 Command Slots Missed (in MEMCLKs) |
| 0        | DCT0 Command Slots Missed (in MEMCLKs) |

### NBPMCx3EF Memory Controller Turnarounds

The number of turnarounds on the local DRAM data bus. UnitMask[7:0] may be used to isolate the different cases. These represent lost DRAM bandwidth, which may be calculated as follows (in bytes per occurrence):

DIMM turnaround:  $\text{DRAM\_width\_in\_bytes} * 2 \text{ edges\_per\_memclk} * 2$   
 R/W turnaround:  $\text{DRAM\_width\_in\_bytes} * 2 \text{ edges\_per\_memclk} * 1$   
 R/W turnaround:  $\text{DRAM\_width\_in\_bytes} * 2 \text{ edges\_per\_memclk} * (\text{Tcl}-1)$

where DRAM\_width\_in\_bytes is 8 or 16 (for single- or dual-channel systems), and Tcl is the CAS latency of the DRAM in memory system clock cycles (where the memory clock for DDR-400, or PC3200 DIMMS, for example, would be 200 MHz).

| UnitMask | Description                        |
|----------|------------------------------------|
| 7:6      | Reserved.                          |
| 5        | DCT1 Write to read turnaround      |
| 4        | DCT1 Read to write turnaround      |
| 3        | DCT1 DIMM (chip select) turnaround |
| 2        | DCT0 Write to read turnaround      |
| 1        | DCT0 Read to write turnaround      |
| 0        | DCT0 DIMM (chip select) turnaround |

### 3.24.6 3F[F:0] Events (Memory Controller)

#### NBPMCx3FC DRAM Accesses

The number of memory accesses performed by the local DRAM controller. UnitMask[7:0] may be used to isolate the different DRAM page access cases. Page miss cases incur an extra latency to open a page; page conflict cases incur both a page-close as well as page-open penalties. These penalties may be overlapped by DRAM accesses for other requests and don't necessarily represent lost DRAM bandwidth. The associated penalties are as follows:

Page miss: Trcd (DRAM RAS-to-CAS delay)  
 Page conflict: Trp + Trcd (DRAM row-precharge time plus RAS-to-CAS delay)

Each DRAM access represents one 64-byte block of data transferred if the DRAM is configured for 64-byte granularity, or one 32-byte block if the DRAM is configured for 32-byte granularity. (The latter is only applicable to single-channel DRAM systems, which may be configured either way.)

| UnitMask | Description        |
|----------|--------------------|
| 7:6      | Reserved.          |
| 5        | DCT3 Page Conflict |
| 4        | DCT3 Page Miss     |
| 3        | DCT3 Page hit      |
| 2        | DCT2 Page Conflict |
| 1        | DCT2 Page Miss     |
| 0        | DCT2 Page hit      |

### NBPMCx3FD DRAM Controller Page Table Overflows

The number of page table overflows in the local DRAM controller. This table maintains information about which DRAM pages are open. An overflow occurs when a request for a new page arrives when the maximum number of pages are already open. Each occurrence reflects an access latency penalty equivalent to a page conflict.

| UnitMask | Description              |
|----------|--------------------------|
| 7:2      | Reserved.                |
| 1        | DCT3 Page Table Overflow |
| 0        | DCT2 Page Table Overflow |

### NBPMCx3FE Memory Controller DRAM Command Slots Missed

| UnitMask | Description                            |
|----------|----------------------------------------|
| 7:2      | Reserved.                              |
| 1        | DCT3 Command Slots Missed (in MEMCLKs) |
| 0        | DCT2 Command Slots Missed (in MEMCLKs) |

### NBPMCx3FF Memory Controller Turnarounds

The number of turnarounds on the local DRAM data bus. UnitMask[7:0] may be used to isolate the different cases. These represent lost DRAM bandwidth, which may be calculated as follows (in bytes per occurrence):

DIMM turnaround:  $\text{DRAM\_width\_in\_bytes} * 2 \text{ edges\_per\_memclk} * 2$   
 R/W turnaround:  $\text{DRAM\_width\_in\_bytes} * 2 \text{ edges\_per\_memclk} * 1$   
 R/W turnaround:  $\text{DRAM\_width\_in\_bytes} * 2 \text{ edges\_per\_memclk} * (\text{Tcl}-1)$

where DRAM\_width\_in\_bytes is 8 or 16 (for single- or dual-channel systems), and Tcl is the CAS latency of the DRAM in memory system clock cycles (where the memory clock for DDR-400, or PC3200 DIMMS, for example, would be 200 MHz).

| UnitMask | Description                        |
|----------|------------------------------------|
| 7:6      | Reserved.                          |
| 5        | DCT3 Write to read turnaround      |
| 4        | DCT3 Read to write turnaround      |
| 3        | DCT3 DIMM (chip select) turnaround |
| 2        | DCT2 Write to read turnaround      |
| 1        | DCT2 Read to write turnaround      |
| 0        | DCT2 DIMM (chip select) turnaround |

## 4 Register List

The following is a list of all storage elements, context, and registers provided in this document. Page numbers, register mnemonics, and register names are provided.

|     |                                                     |     |                                                                                       |
|-----|-----------------------------------------------------|-----|---------------------------------------------------------------------------------------|
| 45  | SMMFEC0: SMM IO Trap Offset                         | 192 | D0F0xBC_x3F800: FIRMWARE_FLAGS                                                        |
| 46  | SMMFEC4: Local SMI Status                           | 192 | D0F0xBC_x3F804: FIRMWARE_VID                                                          |
| 46  | SMMFEC8: SMM IO Restart Byte                        | 192 | D0F0xBC_x3F820: PM_INTERVAL_CNTL_0                                                    |
| 47  | SMMFEC9: Auto Halt Restart Offset                   | 193 | D0F0xBC_x3F828: PM_TIMER_PERIOD                                                       |
| 47  | SMMFECA: NMI Mask                                   | 193 | D0F0xBC_x3F9E8: NB_DPM_CONFIG_1                                                       |
| 47  | SMMFED8: SMM SVM State                              | 193 | D0F0xBC_x3F9EC: NB_DPM_CONFIG_2                                                       |
| 48  | SMMFEFC: SMM-Revision Identifier                    | 194 | D0F0xBC_x3FD[8C:00:step14]: LCLK DPM Control 0                                        |
| 48  | SMMFF00: SMM Base Address (SMM_BASE)                | 194 | D0F0xBC_x3FD[94:08:step14]: LCLK DPM Control 2                                        |
| 177 | IOCF8: IO-Space Configuration Address               | 194 | D0F0xBC_x3FD[9C:10:step14]: LCLK DPM Activity Thresholds                              |
| 178 | IOCF8: IO-Space Configuration Data Port             | 195 | D0F0xBC_x3FDC8: SMU_LCLK_DPM_CNTL                                                     |
| 179 | D0F0x00: Device/Vendor ID                           | 195 | D0F0xBC_x3FDD0: SMU_LCLK_DPM_THERMAL_THROTTLING_CNTL                                  |
| 179 | D0F0x04: Status/Command                             | 195 | D0F0xBC_x3FDD4: SMU_LCLK_DPM_THERMAL_THROTTLING_THRESHOLDS                            |
| 179 | D0F0x08: Class Code/Revision ID                     | 195 | D0F0xBC_xC010_40A0: SVI Loadline Configuration                                        |
| 179 | D0F0x0C: Header Type                                | 196 | D0F0xBC_xC020_0110: Activity Monitor Control                                          |
| 180 | D0F0x2C: Subsystem and Subvendor ID                 | 196 | D0F0xBC_xC210_0000: CPU Interrupt Request                                             |
| 180 | D0F0x34: Capabilities Pointer                       | 196 | D0F0xBC_xC210_0004: CPU Interrupt Status                                              |
| 180 | D0F0x48: NB Header Write Register                   | 197 | D0F0xBC_xC210_003C: CPU Interrupt Argument                                            |
| 180 | D0F0x4C: PCI Control                                | 197 | D0F0xBC_xC210_0040: CPU Interrupt Response                                            |
| 181 | D0F0x60: Miscellaneous Index                        | 197 | D0F0xBC_xE000_3040: CONNECTED_STANDBY_CONTROL                                         |
| 181 | D0F0x64: Miscellaneous Index Data                   | 197 | D0F0xC8: DEV Index Address                                                            |
| 181 | D0F0x64_x00: Northbridge Control                    | 197 | D0F0xCC: DEV Index Data                                                               |
| 181 | D0F0x64_x0C: IOC Bridge Control                     | 198 | D0F0xCC_x01_ib[21,1D:19,12:11]: IOC Bridge Control                                    |
| 181 | D0F0x64_x0D: IOC PCI Configuration                  | 198 | D0F0xCC_x02_ib[21,1D:19,12:11]: IOC Bridge Status                                     |
| 182 | D0F0x64_x16: IOC Advanced Error Reporting Control   | 198 | D0F0xD0: GBIF Index Address                                                           |
| 182 | D0F0x64_x17: Memory Mapped IO Base Address          | 199 | D0F0xD4: GBIF Index Data                                                              |
| 182 | D0F0x64_x18: Memory Mapped IO Limit                 | 199 | D0F0xD4_x0109_14E1: CC Bif Bx Strap0 Ind                                              |
| 182 | D0F0x64_x19: Top of Memory 2 Low                    | 199 | D0F0xD4_x0109_14E2: CC Bif Bx Strap1 Ind                                              |
| 182 | D0F0x64_x1A: Top of Memory 2 High                   | 199 | D0F0xD4_x0109_1507: CC Bif Bx Pinstrap0 Ind                                           |
| 183 | D0F0x64_x1D: Internal Graphics PCI Control          | 200 | D0F0xE0: Link Index Address                                                           |
| 183 | D0F0x64_x1F: FCH Location                           | 201 | D0F0xE4: Link Index Data                                                              |
| 183 | D0F0x64_x22: LCLK Control 0                         | 201 | D0F0xE4_x0[210,11[3:0]]_0010: PIF Control                                             |
| 184 | D0F0x64_x23: LCLK Control 1                         | 201 | D0F0xE4_x0[210,11[3:0]]_0011: PIF Pairing                                             |
| 184 | D0F0x64_x3[B:0]: Programmable Device Remap Register | 202 | D0F0xE4_x0[210,11[3:0]]_001[8:7,3:2]: PIF Power Down Control [3:0]                    |
| 185 | D0F0x64_x46: IOC Features Control                   | 204 | D0F0xE4_x0[220,123:120]_0000: Phy Compensation Control and Calibration Control I      |
| 185 | D0F0x7C: IOC Configuration Control                  | 205 | D0F0xE4_x0[220,123:120]_000[2:1]: Phy Impedance Control                               |
| 186 | D0F0x84: Link Arbitration                           | 206 | D0F0xE4_x0[220,123:120]_000[C:B]: Phy Serial Bus Packet Control                       |
| 186 | D0F0x90: Northbridge Top of Memory                  | 208 | D0F0xE4_x0[220,123:120]_[5:4][7:6,3:0][8,0]2: Phy Receiver Phase Loop Filter Control  |
| 186 | D0F0x94: Northbridge ORB Configuration Offset       | 210 | D0F0xE4_x0[220,123:120]_[5:4][7:6,3:0][8,0]5: Phy Receiver Timing Margin Test         |
| 186 | D0F0x98: Northbridge ORB Configuration Data Port    | 211 | D0F0xE4_x0[220,123:120]_[5:4][7:6,3:0][8,0]6: Phy Receiver DFE and DFR Control        |
| 187 | D0F0x98_x02: ORB PGMEM Control                      | 212 | D0F0xE4_x0[220,123:120]_[5:4][7:6,3:0][8,0]A: Phy DLL Test and Control 3              |
| 187 | D0F0x98_x06: ORB Downstream Control 0               | 214 | D0F0xE4_x0[220,123:120]_[7:6][7:6,3:0][8,0]0: Phy Tx Deemphasis and Margining Control |
| 187 | D0F0x98_x07: ORB Upstream Arbitration Control 0     | 215 | D0F0xE4_x0[220,123:120]_[7:6][7:6,3:0][8,0]6: Phy Transmit Nominal Deemphasis Control |
| 188 | D0F0x98_x08: ORB Upstream Arbitration Control 1     | 216 | D0F0xE4_x0[220,123:120]_[F:E][7:0][8,0]6: Phy Transmit Link Configuration             |
| 188 | D0F0x98_x09: ORB Upstream Arbitration Control 2     | 218 | D0F0xE4_x013[2:0]_0046: Subsystem and Vendor ID                                       |
| 188 | D0F0x98_x0C: ORB Upstream Arbitration Control 5     | 218 | D0F0xE4_x013[2:0]_0080: Link Configuration                                            |
| 189 | D0F0x98_x1E: ORB Receive Control 0                  | 218 | D0F0xE4_x013[2:0]_0[C:8]00: Link Hold Training Control                                |
| 189 | D0F0x98_x26: ORB IOMMU Control 0                    | 219 | D0F0xE4_x013[2:0]_0[C:8]03: Link Deemphasis Control                                   |
| 189 | D0F0x98_x27: ORB IOMMU Control 1                    | 219 | D0F0xE4_x013[3:0]_8002: IO Link Wrapper Scratch                                       |
| 190 | D0F0x98_x28: ORB Transmit Control 0                 | 219 | D0F0xE4_x013[3:0]_8011: Link Transmit Clock Gating Control                            |
| 190 | D0F0x98_x2C: ORB Clock Control                      | 220 | D0F0xE4_x013[3:0]_8012: Link Idle-Resume Clock Gating Control                         |
| 190 | D0F0x98_x37: ORB Allow LDTSTOP Control 0            | 220 | D0F0xE4_x013[3:0]_8013: Transmit Clock PII Control                                    |
| 190 | D0F0x98_x3A: ORB Source Tag Translation Control 2   | 221 | D0F0xE4_x013[3:0]_8014: Link Transmit Clock Gating Control 2                          |
| 191 | D0F0x98_x3B: ORB Source Tag Translation Control 3   | 222 | D0F0xE4_x013[3:0]_8015: IO Link IOC Control                                           |
| 191 | D0F0x98_x4[A,9]: ORB LCLK Clock Control 1-0         |     |                                                                                       |
| 192 | D0F0xB8: SMU Index Address                          |     |                                                                                       |
| 192 | D0F0xBC: SMU Index Data                             |     |                                                                                       |

|     |                                                        |     |                                        |
|-----|--------------------------------------------------------|-----|----------------------------------------|
| 222 | D0F0xE4_x013[3:0]_8016: Link Clock Switching Control   | 245 | D0F2xF4_x14: L2_ITC_CONTROL            |
| 223 | D0F0xE4_x013[3:0]_802[4:1]: Transmitter Lane Mux       | 245 | D0F2xF4_x15: L2_ITC_HASH_CONTROL       |
| 224 | D0F0xE4_x013[3:0]_802[8:5]: Receiver Lane Mux          | 246 | D0F2xF4_x16: L2_ITC_WAY_CONTROL        |
| 225 | D0F0xE4_x013[3:0]_8029: Lane Enable                    | 246 | D0F2xF4_x18: L2_PTC_A_CONTROL          |
| 225 | D0F0xE4_x013[3:0]_804[3:0]: DDI Slice                  | 247 | D0F2xF4_x19: L2_PTC_A_HASH_CONTROL     |
| 226 | D0F0xE4_x013[3:0]_804[E:8]: DDI Dig                    | 247 | D0F2xF4_x1A: L2_PTC_A_WAY_CONTROL      |
| 227 | D0F0xE4_x013[3:0]_8060: Soft Reset Command 0           | 247 | D0F2xF4_x1C: L2_PTC_B_CONTROL          |
| 227 | D0F0xE4_x013[3:0]_8062: Soft Reset Control 0           | 248 | D0F2xF4_x1D: L2_PTC_B_HASH_CONTROL     |
| 228 | D0F0xE4_x0132_80F0: BIOS Timer                         | 248 | D0F2xF4_x1E: L2_PTC_B_WAY_CONTROL      |
| 228 | D0F0xE4_x0132_80F1: BIOS Timer Control                 | 249 | D0F2xF4_x20: L2_CREDIT_CONTROL_2       |
| 228 | D0F0xE4_x014[2:0]_0002: IO Link Hardware Debug         | 249 | D0F2xF4_x22: L2A_UPDATE_FILTER_CNTL    |
| 228 | D0F0xE4_x014[2:0]_0010: IO Link Control 1              | 249 | D0F2xF4_x30: L2_ERR_RULE_CONTROL_3     |
| 229 | D0F0xE4_x014[2:0]_0011: IO Link Config Control         | 249 | D0F2xF4_x31: L2_ERR_RULE_CONTROL_4     |
| 229 | D0F0xE4_x014[2:0]_001C: IO Link Control 2              | 250 | D0F2xF4_x32: L2_ERR_RULE_CONTROL_5     |
| 230 | D0F0xE4_x014[2:0]_0020: IO Link Chip Interface Control | 250 | D0F2xF4_x33: L2_L2A_CK_GATE_CONTROL    |
| 230 | D0F0xE4_x014[2:0]_0040: IO Link Phy Control            | 250 | D0F2xF4_x34: L2_L2A_PGFSIZE_CONTROL    |
| 230 | D0F0xE4_x014[2:0]_00B0: IO Link Strap Control          | 250 | D0F2xF4_x3B: IOMMU_PGFSM_CONFIG        |
| 230 | D0F0xE4_x014[2:0]_00C0: IO Link Strap Miscellaneous    | 251 | D0F2xF4_x3C: IOMMU_PGFSM_WRITE         |
| 231 | D0F0xE4_x014[2:0]_00C1: IO Link Strap Miscellaneous2   | 251 | D0F2xF4_x3D: IOMMU_PGFSM_READ          |
| 231 | D0F0xF8: Northbridge IOAPIC Index                      | 251 | D0F2xF4_x40: L2_PERF_CNTL_2            |
| 231 | D0F0xFC: Northbridge IOAPIC Data                       | 251 | D0F2xF4_x41: L2_PERF_COUNT_4           |
| 231 | D0F0xFC_x00: IOAPIC Feature Control Register           | 251 | D0F2xF4_x42: L2_PERF_COUNT_5           |
| 232 | D0F0xFC_x01: IOAPIC Base Address Lower                 | 252 | D0F2xF4_x43: L2_PERF_CNTL_3            |
| 232 | D0F0xFC_x02: IOAPIC Base Address Upper                 | 252 | D0F2xF4_x44: L2_PERF_COUNT_6           |
| 232 | D0F0xFC_x0F: IOAPIC GBIF Interrupt Routing Register    | 252 | D0F2xF4_x45: L2_PERF_COUNT_7           |
| 232 | D0F0xFC_x1[B:0]: IOAPIC BR Interrupt Routing Register  | 252 | D0F2xF4_x46: L2_DEBUG_2                |
| 233 | D0F0xFC_x30: IOAPIC Serial IRQ Status                  | 252 | D0F2xF4_x47: L2_DEBUG_3                |
| 233 | D0F0xFC_x3[F:E]: IOAPIC Scratch [1:0] Register         | 252 | D0F2xF4_x48: L2_STATUS_1               |
| 234 | D0F2x00: Device/Vendor ID                              | 253 | D0F2xF4_x49: L2_SB_LOCATION            |
| 234 | D0F2x04: Status/Command                                | 253 | D0F2xF4_x4C: L2_CONTROL_5              |
| 235 | D0F2x08: Class Code/Revision ID                        | 254 | D0F2xF4_x4D: L2_CONTROL_6              |
| 235 | D0F2x0C: Header Type                                   | 254 | D0F2xF4_x50: L2_PDC_CONTROL            |
| 235 | D0F2x2C: Subsystem and Subvendor ID                    | 255 | D0F2xF4_x51: L2_PDC_HASH_CONTROL       |
| 235 | D0F2x34: Capabilities Pointer                          | 255 | D0F2xF4_x52: L2_PDC_WAY_CONTROL        |
| 235 | D0F2x3C: Interrupt Line                                | 255 | D0F2xF4_x53: L2B_UPDATE_FILTER_CNTL    |
| 236 | D0F2x40: IOMMU Capability                              | 256 | D0F2xF4_x54: L2_TW_CONTROL             |
| 236 | D0F2x44: IOMMU Base Address Low                        | 256 | D0F2xF4_x56: L2_CP_CONTROL             |
| 237 | D0F2x48: IOMMU Base Address High                       | 256 | D0F2xF4_x57: L2_CP_CONTROL_1           |
| 237 | D0F2x4C: IOMMU Range                                   | 257 | D0F2xF4_x58: IOMMU_L2_GUEST_ADDR_CNTRL |
| 237 | D0F2x50: IOMMU Miscellaneous Information Register      | 257 | D0F2xF4_x60: L2_TW_CONTROL_1           |
| 238 | D0F2x54: IOMMU MSI Capability Register                 | 257 | D0F2xF4_x61: L2_TW_CONTROL_2           |
| 239 | D0F2x58: IOMMU MSI Address Low                         | 257 | D0F2xF4_x62: L2_TW_CONTROL_3           |
| 239 | D0F2x5C: IOMMU MSI Address High                        | 257 | D0F2xF4_x6A: L2_INT_CONTROL            |
| 239 | D0F2x60: IOMMU MSI Data                                | 258 | D0F2xF4_x70: L2_CREDIT_CONTROL_0       |
| 239 | D0F2x64: IOMMU MSI Mapping Capability                  | 258 | D0F2xF4_x71: L2_CREDIT_CONTROL_1       |
| 239 | D0F2x6C: IOMMU Control                                 | 259 | D0F2xF4_x78: L2_MCIF_CONTROL           |
| 240 | D0F2x70: IOMMU MMIO Control Low                        | 259 | D0F2xF4_x80: L2_ERR_RULE_CONTROL_0     |
| 240 | D0F2x74: IOMMU MMIO Control High                       | 259 | D0F2xF4_x81: L2_ERR_RULE_CONTROL_1     |
| 240 | D0F2x78: IOMMU Range Control                           | 259 | D0F2xF4_x82: L2_ERR_RULE_CONTROL_2     |
| 240 | D0F2xF0: IOMMU L2 Config Index                         | 260 | D0F2xF4_x90: L2_L2B_CK_GATE_CONTROL    |
| 241 | D0F2xF4: IOMMU L2 Config Data                          | 260 | D0F2xF4_x92: PPR_CONTROL               |
| 241 | D0F2xF4_x00: L2_PERF_CNTL_0                            | 260 | D0F2xF4_x94: L2_L2B_PGFSIZE_CONTROL    |
| 241 | D0F2xF4_x01: L2_PERF_COUNT_0                           | 260 | D0F2xF8: IOMMU L1 Config Index         |
| 241 | D0F2xF4_x02: L2_PERF_COUNT_1                           | 261 | D0F2xFC: IOMMU L1 Config Data          |
| 241 | D0F2xF4_x03: L2_PERF_CNTL_1                            | 261 | D0F2xFC_x00_L1i[4:0]: L1_PERF_CNTL     |
| 242 | D0F2xF4_x04: L2_PERF_COUNT_2                           | 261 | D0F2xFC_x01_L1i[4:0]: L1_PERF_COUNT_0  |
| 242 | D0F2xF4_x05: L2_PERF_COUNT_3                           | 261 | D0F2xFC_x02_L1i[4:0]: L1_PERF_COUNT_1  |
| 242 | D0F2xF4_x08: L2_STATUS_0                               | 262 | D0F2xFC_x07_L1i[4:0]: L1_DEBUG_1       |
| 242 | D0F2xF4_x0C: L2_CONTROL_0                              | 262 | D0F2xFC_x09_L1i[4:0]: L1_SB_LOCATION   |
| 243 | D0F2xF4_x0D: L2_CONTROL_1                              | 262 | D0F2xFC_x0C_L1i[4:0]: L1_CNTRL_0       |
| 243 | D0F2xF4_x10: L2_DTC_CONTROL                            | 263 | D0F2xFC_x0D_L1i[4:0]: L1_CNTRL_1       |
| 244 | D0F2xF4_x11: L2_DTC_HASH_CONTROL                       | 264 | D0F2xFC_x0E_L1i[4:0]: L1_CNTRL_2       |
| 244 | D0F2xF4_x12: L2_DTC_WAY_CONTROL                        | 264 | D0F2xFC_x0F_L1i[4:0]: L1_CNTRL_3       |

|     |                                                        |     |                                                                 |
|-----|--------------------------------------------------------|-----|-----------------------------------------------------------------|
| 264 | D0F2xFC_x10_L1i[4:0]: L1_BANK_SEL_0                    | 285 | D1F1x54: Power Management Control and Status                    |
| 264 | D0F2xFC_x11_L1i[4:0]: L1_BANK_DISABLE_0                | 285 | D1F1x58: PCI Express Capability                                 |
| 265 | D0F2xFC_x20_L1i[4:0]: L1_WQ_STATUS_0                   | 285 | D1F1x5C: Device Capability                                      |
| 265 | D0F2xFC_x21_L1i[4:0]: L1_WQ_STATUS_1                   | 286 | D1F1x60: Device Control and Status                              |
| 266 | D0F2xFC_x22_L1i[4:0]: L1_WQ_STATUS_2                   | 287 | D1F1x64: Link Capability                                        |
| 266 | D0F2xFC_x23_L1i[4:0]: L1_WQ_STATUS_3                   | 287 | D1F1x68: Link Control and Status                                |
| 266 | D0F2xFC_x32_L1i[4:0]: L1_CNTRL_4                       | 288 | D1F1x7C: Device Capability 2                                    |
| 267 | D0F2xFC_x33_L1i[4:0]: L1_CLKCNTRL_0                    | 288 | D1F1x80: Device Control and Status 2                            |
| 267 | D0F2xFC_x34_L1i[4:0]: L1_MEMPWRCNTRL_0                 | 289 | D1F1x84: Link Capability 2                                      |
| 267 | D0F2xFC_x35_L1i[4:0]: L1_MEMPWRCNTRL_1                 | 289 | D1F1x88: Link Control and Status 2                              |
| 267 | D0F2xFC_x36_L1i[4:0]: L1_GUEST_ADDR_CNTRL              | 289 | D1F1xA0: MSI Capability                                         |
| 268 | D0F2xFC_x37_L1i[4:0]: L1_FEATURE_SUP_CNTRL             | 290 | D1F1xA4: MSI Message Address Low                                |
| 268 | D0F2xFC_x38_L1i[4:0]: L1_CNTRL_5                       | 290 | D1F1xA8: MSI Message Address High                               |
| 269 | D1F0x00: Device/Vendor ID                              | 290 | D1F1xAC: MSI Message Data                                       |
| 269 | D1F0x04: Status/Command Register                       | 290 | D1F1x100: Vendor Specific Enhanced Capability                   |
| 270 | D1F0x08: Class Code/Revision ID Register               | 290 | D1F1x104: Vendor Specific Header                                |
| 270 | D1F0x0C: Header Type Register                          | 291 | D1F1x108: Vendor Specific 1                                     |
| 270 | D1F0x10: Graphic Memory Base Address                   | 291 | D1F1x10C: Vendor Specific 2                                     |
| 271 | D1F0x14: Graphics Memory Base Address 64               | 292 | D[4:2]F0x00: Device/Vendor ID (Host Bridge)                     |
| 271 | D1F0x18: Graphics Doorbell Base Address                | 292 | D[4:2]F0x04: Status/Command                                     |
| 271 | D1F0x1C: Graphics Doorbell Base Address 64             | 292 | D[4:2]F0x08: Class Code/Revision ID                             |
| 271 | D1F0x20: Graphics IO Base Address                      | 292 | D[4:2]F0x0C: Header Type                                        |
| 272 | D1F0x24: Graphics Memory Mapped Registers Base Address | 293 | D[4:2]F0x40: Header Type Write                                  |
| 272 | D1F0x2C: Subsystem and Subvendor ID Register           | 293 | D[4:2]F[5:1]x00: Device/Vendor ID                               |
| 272 | D1F0x30: Expansion ROM Base Address                    | 294 | D[4:2]F[5:1]x04: Status/Command Register                        |
| 272 | D1F0x34: Capabilities Pointer                          | 295 | D[4:2]F[5:1]x08: Class Code/Revision ID Register                |
| 272 | D1F0x3C: Interrupt Line                                | 295 | D[4:2]F[5:1]x0C: Header Type Register                           |
| 273 | D1F0x4C: Subsystem and Subvendor ID Mirror             | 295 | D[4:2]F[5:1]x18: Bus Number and Secondary Latency Register      |
| 273 | D1F0x50: Power Management Capability                   | 295 | D[4:2]F[5:1]x1C: IO Base and Secondary Status Register          |
| 273 | D1F0x54: Power Management Control and Status           | 296 | D[4:2]F[5:1]x20: Memory Limit and Base Register                 |
| 274 | D1F0x58: PCI Express Capability                        | 296 | D[4:2]F[5:1]x24: Prefetchable Memory Limit and Base Register    |
| 274 | D1F0x5C: Device Capability                             | 297 | D[4:2]F[5:1]x28: Prefetchable Memory Base High Register         |
| 274 | D1F0x60: Device Control and Status                     | 297 | D[4:2]F[5:1]x2C: Prefetchable Memory Limit High Register        |
| 275 | D1F0x64: Link Capability                               | 297 | D[4:2]F[5:1]x30: IO Base and Limit High Register                |
| 276 | D1F0x68: Link Control and Status                       | 297 | D[4:2]F[5:1]x34: Capabilities Pointer Register                  |
| 277 | D1F0x7C: Device Capability 2                           | 297 | D[4:2]F[5:1]x3C: Bridge Control Register                        |
| 277 | D1F0x80: Device Control and Status 2                   | 298 | D[4:2]F[5:1]x50: Power Management Capability Register           |
| 278 | D1F0x84: Link Capability 2                             | 298 | D[4:2]F[5:1]x54: Power Management Control and Status Register   |
| 278 | D1F0x88: Link Control and Status 2                     | 299 | D[4:2]F[5:1]x58: PCI Express Capability Register                |
| 278 | D1F0xA0: MSI Capability                                | 299 | D[4:2]F[5:1]x5C: Device Capability Register                     |
| 279 | D1F0xA4: MSI Message Address Low                       | 300 | D[4:2]F[5:1]x60: Device Control and Status Register             |
| 279 | D1F0xA8: MSI Message Address High                      | 301 | D[4:2]F[5:1]x64: IO Link Capability Register                    |
| 279 | D1F0xAC: MSI Message Data                              | 302 | D[4:2]F[5:1]x68: IO Link Control and Status Register            |
| 279 | D1F0x100: Vendor Specific Enhanced Capability          | 304 | D[4:2]F[5:1]x6C: Slot Capability Register                       |
| 280 | D1F0x104: Vendor Specific Header                       | 305 | D[4:2]F[5:1]x70: Slot Control and Status Register               |
| 280 | D1F0x108: Vendor Specific 1                            | 306 | D[4:2]F[5:1]x74: Root Complex Capability and Control Register   |
| 280 | D1F0x10C: Vendor Specific 2                            | 306 | D[4:2]F[5:1]x78: Root Complex Status Register                   |
| 281 | D1F1x00: Device/Vendor ID                              | 306 | D[4:2]F[5:1]x7C: Device Capability 2                            |
| 281 | D1F1x04: Status/Command                                | 307 | D[4:2]F[5:1]x80: Device Control and Status 2                    |
| 282 | D1F1x08: Class Code/Revision ID                        | 308 | D[4:2]F[5:1]x84: IO Link Capability 2                           |
| 282 | D1F1x0C: Header Type                                   | 308 | D[4:2]F[5:1]x88: IO Link Control and Status 2                   |
| 282 | D1F1x10: Audio Registers Base Address                  | 309 | D[4:2]F[5:1]x8C: Slot Capability 2                              |
| 282 | D1F1x14: Base Address 1                                | 310 | D[4:2]F[5:1]x90: Slot Control and Status 2                      |
| 283 | D1F1x18: Base Address 2                                | 310 | D[4:2]F[5:1]xA0: MSI Capability Register                        |
| 283 | D1F1x1C: Base Address 3                                | 310 | D[4:2]F[5:1]xA4: MSI Message Address Low                        |
| 283 | D1F1x20: Base Address 4                                | 310 | D[4:2]F[5:1]xA8: MSI Message Address High                       |
| 283 | D1F1x24: Base Address 5                                | 311 | D[4:2]F[5:1]xAC: MSI Message Data                               |
| 283 | D1F1x2C: Subsystem and Subvendor ID                    | 311 | D[4:2]F[5:1]xB0: Subsystem and Subvendor Capability ID Register |
| 283 | D1F1x30: Expansion ROM Base Address                    | 311 | D[4:2]F[5:1]xB4: Subsystem and Subvendor ID Register            |
| 284 | D1F1x34: Capabilities Pointer                          | 311 | D[4:2]F[5:1]xB8: MSI Capability Mapping                         |
| 284 | D1F1x3C: Interrupt Line                                | 311 | D[4:2]F[5:1]xBC: MSI Mapping Address Low                        |
| 284 | D1F1x4C: Subsystem and Subvendor ID Mirror             | 312 | D[4:2]F[5:1]xC0: MSI Mapping Address High                       |
| 284 | D1F1x50: Power Management Capability                   | 312 | D[4:2]F[5:1]xE0: Root Port Index                                |

|     |                                                                |     |                                                                            |
|-----|----------------------------------------------------------------|-----|----------------------------------------------------------------------------|
| 312 | D[4:2]F[5:1]xE4: Root Port Data                                | 347 | D18F1x[1DC:1D0,EC:E0]: Configuration Map                                   |
| 312 | D[4:2]F[5:1]xE4_x20: Root Port TX Control                      | 347 | D18F1xF0: DRAM Hole Address                                                |
| 312 | D[4:2]F[5:1]xE4_x50: Root Port Lane Status                     | 348 | D18F1xF4: VGA Enable                                                       |
| 313 | D[4:2]F[5:1]xE4_x6A: Root Port Error Control                   | 349 | D18F1x10C: DCT Configuration Select                                        |
| 313 | D[4:2]F[5:1]xE4_x70: Root Port Receiver Control                | 350 | D18F1x120: DRAM Base System Address                                        |
| 313 | D[4:2]F[5:1]xE4_xA0: Per Port Link Controller (LC) Control     | 350 | D18F1x124: DRAM Limit System Address                                       |
| 314 | D[4:2]F[5:1]xE4_xA1: LC Training Control                       | 351 | D18F1x2[1C:00]: DRAM Controller Base/Limit                                 |
| 314 | D[4:2]F[5:1]xE4_xA2: LC Link Width Control                     | 352 | D18F1x2[4C:40]: DRAM Controller High Address Offset Register               |
| 315 | D[4:2]F[5:1]xE4_xA3: LC Number of FTS Control                  | 354 | D18F2x00: Device/Vendor ID                                                 |
| 315 | D[4:2]F[5:1]xE4_xA4: LC Link Speed Control                     | 354 | D18F2x08: Class Code/Revision ID                                           |
| 316 | D[4:2]F[5:1]xE4_xA5: LC State 0                                | 354 | D18F2x0C: Header Type                                                      |
| 317 | D[4:2]F[5:1]xE4_xB1: LC Control 2                              | 354 | D18F2x[5C:40]_dct[3:0]: DRAM CS Base Address                               |
| 317 | D[4:2]F[5:1]xE4_xB5: LC Control 3                              | 356 | D18F2x[6C:60]_dct[3:0]: DRAM CS Mask                                       |
| 318 | D[4:2]F[5:1]xE4_xC0: LC Strap Override                         | 356 | D18F2x78_dct[3:0]: DRAM Control                                            |
| 318 | D[4:2]F[5:1]xE4_xC1: Root Port Miscellaneous Strap Override    | 357 | D18F2x7C_dct[3:0]: DRAM Initialization                                     |
| 318 | D[4:2]F[5:1]xE4_xD0: Root Port ECC Skip OS Feature             | 359 | D18F2x80_dct[3:0]: DRAM Bank Address Mapping                               |
| 318 | D[4:2]F[5:1]x100: Vendor Specific Enhanced Capability Register | 359 | D18F2x84_dct[3:0]: DRAM MRS                                                |
| 319 | D[4:2]F[5:1]x104: Vendor Specific Header Register              | 360 | D18F2x88_dct[3:0]: DRAM Timing Low                                         |
| 319 | D[4:2]F[5:1]x108: Vendor Specific 1 Register                   | 361 | D18F2x8C_dct[3:0]: DRAM Timing High                                        |
| 319 | D[4:2]F[5:1]x10C: Vendor Specific 2 Register                   | 361 | D18F2x90_dct[3:0]: DRAM Configuration Low                                  |
| 319 | D[4:2]F[5:1]x128: Virtual Channel 0 Resource Status Register   | 363 | D18F2x94_dct[3:0]: DRAM Configuration High                                 |
| 319 | D[4:2]F[5:1]x150: Advanced Error Reporting Capability          | 366 | D18F2x98_dct[3:0]: DRAM Controller Additional Data Offset                  |
| 320 | D[4:2]F[5:1]x154: Uncorrectable Error Status                   | 367 | D18F2x9C_dct[3:0]: DRAM Controller Additional Data Port                    |
| 320 | D[4:2]F[5:1]x158: Uncorrectable Error Mask                     | 367 | D18F2x9C_x00[F,3:0]0_0009_dct[3:0]: High Addr Mode                         |
| 321 | D[4:2]F[5:1]x15C: Uncorrectable Error Severity                 | 367 | D18F2x9C_x0000_000E_dct[3:0]: Global Control Slave                         |
| 322 | D[4:2]F[5:1]x160: Correctable Error Status                     | 367 | D18F2x9C_x0[3,1:0][F,3:0]0_0014_dct[3:0]: Dll Lock Maintenance             |
| 322 | D[4:2]F[5:1]x164: Correctable Error Mask                       | 368 | D18F2x9C_x00F0_0015_dct[3:0]: Vref Byte                                    |
| 323 | D[4:2]F[5:1]x168: Advanced Error Control                       | 368 | D18F2x9C_x0[3,1:0][F,3:0]0_[F,3:0]028_dct[3:0]: CAD RdPtrOffset            |
| 323 | D[4:2]F[5:1]x16C: Header Log DW0                               | 368 | D18F2x9C_x00[F,3:0]0_[F,3:0][8,3:0]2E_dct[3:0]: RdPtrInitVal               |
| 323 | D[4:2]F[5:1]x170: Header Log DW1                               | 369 | D18F2x9C_x0[3,1:0][F,3:0]0_[F,B:0]041_dct[3:0]: CAD Tx Impedance           |
| 323 | D[4:2]F[5:1]x174: Header Log DW2                               | 370 | D18F2x9C_x00[F,3:0]0_[F,B:0]04A_dct[3:0]: Rx Control 1                     |
| 324 | D[4:2]F[5:1]x178: Header Log DW3                               | 370 | D18F2x9C_x00[F,3:0]0_[F,B:0]04E_dct[3:0]: TxControlDq                      |
| 324 | D[4:2]F[5:1]x17C: Root Error Command                           | 371 | D18F2x9C_x00[F,3:0]0_[F,B:0]05F_dct[3:0]: CAD Tx Slew Rate                 |
| 324 | D[4:2]F[5:1]x180: Root Error Status                            | 371 | D18F2x9C_x00[F,3:0]0_0077_dct[3:0]: DllPowerdown                           |
| 325 | D[4:2]F[5:1]x184: Error Source ID                              | 372 | D18F2x9C_x00[F,3:0]0_0078_dct[3:0]: DllControl                             |
| 326 | D18F0x00: Device/Vendor ID                                     | 372 | D18F2x9C_x0[3,1:0][F,3:0]0_[F,3:0]081_dct[3:0]: Tx Delay                   |
| 326 | D18F0x04: Status/Command                                       | 373 | D18F2x9C_x00[F,8:0]1_0000_dct[3:0]: VariousChicken                         |
| 326 | D18F0x08: Class Code/Revision ID                               | 373 | D18F2x9C_x0001_000E_dct[3:0]: Global Control Slave                         |
| 326 | D18F0x0C: Header Type                                          | 373 | D18F2x9C_x0[3,1:0][F,8:0]1_0014_dct[3:0]: Dll Lock Maintenance             |
| 326 | D18F0x34: Capabilities Pointer                                 | 375 | D18F2x9C_x00F1_0015_dct[3:0]: Vref Byte                                    |
| 326 | D18F0x[5C:40]: Routing Table                                   | 375 | D18F2x9C_x00[F,8:0]1_0016_dct[3:0]: Proc Odt Timing                        |
| 327 | D18F0x60: Node ID                                              | 376 | D18F2x9C_x00[F,8:0]1_001C_dct[3:0]: Dynamic PowerDown                      |
| 327 | D18F0x64: Unit ID                                              | 376 | D18F2x9C_x0[3,1:0][F,8:0]1_0028_dct[3:0]: DATA RdPtrOffset                 |
| 328 | D18F0x68: Link Transaction Control                             | 377 | D18F2x9C_x0[3,1:0][F,8:0]1_0029_dct[3:0]: Dll Early Traffic Offset         |
| 329 | D18F0x6C: Link Initialization Control                          | 377 | D18F2x9C_x0[3,1:0][F,8:0]1_002A_dct[3:0]: Rx Dll Standby Stagger Config    |
| 331 | D18F0x[E4,C4,A4,84]: Link Control                              | 377 | D18F2x9C_x0[3,1:0][F,8:0]1_002B_dct[3:0]: Tx Dll Standby Stagger Config    |
| 331 | D18F0x[EC,CC,AC,8C]: Link Feature Capability                   | 378 | D18F2x9C_x0[3,1:0][F,8:0]1_002C_dct[3:0]: Rx Pad Traffic Early Offset      |
| 332 | D18F0x[F0,D0,B0,90]: Link Base Channel Buffer Count            | 378 | D18F2x9C_x00[F,8:0]1_0[8,3:0]2E_dct[3:0]: DATA RdPtrInitVal                |
| 334 | D18F0x[F4,D4,B4,94]: Link Isochronous Channel Buffer Count     | 379 | D18F2x9C_x0[3,1:0][F,8:0]1_[F,B:0]041_dct[3:0]: DATA Tx Impedance          |
| 335 | D18F0x[F8,D8,B8,98]: Link Type                                 | 380 | D18F2x9C_x0[3,1:0][F,8:0]1_[F,7:0]043_dct[3:0]: DATA Rcv Majormode         |
| 336 | D18F0x[11C,118,114,110]: Link Clumping Enable                  | 381 | D18F2x9C_x0[3,1:0][F,8:0]1_[F,7:0]045_dct[3:0]: DATA VrefNom               |
| 336 | D18F0x150: Link Global Retry Control                           | 381 | D18F2x9C_x0[3,1:0][F,8:0]1_[F,B:0]046_dct[3:0]: DATA Tx EQ HI Impedance    |
| 336 | D18F0x168: Extended Link Transaction Control                   | 382 | D18F2x9C_x0[3,1:0][F,8:0]1_[F,B:0]047_dct[3:0]: DATA Tx EQ LO Impedance    |
| 337 | D18F0x16C: Link Global Extended Control                        | 383 | D18F2x9C_x0[3,1:0][F,8:0]1_[F,B:0]048_dct[3:0]: DATA Tx EQ Boost Impedance |
| 337 | D18F0x[18C:170]: Link Extended Control                         | 383 | D18F2x9C_x00[F,8:0]1_[F,B:0]04A_dct[3:0]: DqDqs Rx Control                 |
| 337 | D18F0x1A0: Link Initialization Status                          |     |                                                                            |
| 338 | D18F0x1DC: Core Enable                                         |     |                                                                            |
| 339 | D18F1x00: Device/Vendor ID                                     |     |                                                                            |
| 339 | D18F1x08: Class Code/Revision ID                               |     |                                                                            |
| 339 | D18F1x0C: Header Type                                          |     |                                                                            |
| 339 | D18F1x[17C:140,7C:40]: DRAM Base/Limit                         |     |                                                                            |
| 341 | D18F1x[2CC:2A0,1CC:180,BC:80]: MMIO Base/Limit                 |     |                                                                            |
| 345 | D18F1x[DC:C0]: IO-Space Base/Limit                             |     |                                                                            |



|     |                                                                   |     |                                                                  |
|-----|-------------------------------------------------------------------|-----|------------------------------------------------------------------|
| 384 | D18F2x9C_x0[3,1:0][F,8:0]1_[F,B:0]04D_dct[3:0]: DATA Rx Impedance | 422 | D18F2x228_dct[3:0]: DDR3 DRAM Timing 9                           |
| 385 | D18F2x9C_x00[F,8:0]1_[F,B:0]04E_dct[3:0]: TxControlDq             | 422 | D18F2x22C_dct[3:0]_mp[1:0]: DDR3 DRAM Timing 10                  |
| 385 | D18F2x9C_x00[F,8:0]1_[F,B:0]051_dct[3:0]: DqDqsRcvCntrl3          | 423 | D18F2x[234:230]_dct[3:0]: DDR3 DRAM Read ODT Pattern [High:Low]  |
| 386 | D18F2x9C_x00[F,8:0]1_[F,B:0]05F_dct[3:0]: DATA Tx Slew Rate       | 423 | D18F2x[23C:238]_dct[3:0]: DDR3 DRAM Write ODT Pattern [High:Low] |
| 387 | D18F2x9C_x00[F,8:0]1_0[F,2:0]77_dct[3:0]: DllPowerdown            | 424 | D18F2x240_dct[3:0]_mp[1:0]: DDR3 DRAM ODT Control                |
| 387 | D18F2x9C_x00[F,8:0]1_0[F,2:0]78_dct[3:0]: DllControl              | 424 | D18F2x244_dct[3:0]: DRAM Controller Miscellaneous 3              |
| 388 | D18F2x9C_x0[F,1:0][F,8:0]1_[F,9:0][F,3:0]80_dct[3:0]: Rx Delay    | 425 | D18F2x248_dct[3:0]_mp[1:0]: DRAM Power Management 0              |
| 389 | D18F2x9C_x0[F,1:0][F,8:0]1_[F,9:0][F,3:0]81_dct[3:0]: Tx Delay    | 426 | D18F2x24C_dct[3:0]: DDR3 DRAM Power Management 1                 |
| 390 | D18F2x9C_x0002_0000_dct[3:0]: Pll MemoryPstate0                   | 427 | D18F2x250_dct[3:0]: DRAM Loopback and Training Control           |
| 391 | D18F2x9C_x0002_0001_dct[3:0]: Pll MemoryPstate1                   | 428 | D18F2x25[8,4]_dct[3:0]: DRAM Target [B, A] Base                  |
| 391 | D18F2x9C_x0002_0004_dct[3:0]: Mailbox Protocol Shadow             | 428 | D18F2x25C_dct[3:0]: DRAM Command 0                               |
| 391 | D18F2x9C_x0002_000B_dct[3:0]: Power State Command                 | 429 | D18F2x260_dct[3:0]: DRAM Command 1                               |
| 392 | D18F2x9C_x0002_000E_dct[3:0]: Global Control                      | 429 | D18F2x264_dct[3:0]: DRAM Status 0                                |
| 392 | D18F2x9C_x00F2_0015_dct[3:0]: Vref Byte                           | 430 | D18F2x268_dct[3:0]: DRAM Status 1                                |
| 392 | D18F2x9C_x0002_0032_dct[3:0]: US Mailbox 1 Message                | 430 | D18F2x26C_dct[3:0]: DRAM Status 2                                |
| 392 | D18F2x9C_x0002_0033_dct[3:0]: US Mailbox 1 Protocol               | 431 | D18F2x270_dct[3:0]: DRAM PRBS                                    |
| 393 | D18F2x9C_x0002_0034_dct[3:0]: US Mailbox 2 Message                | 431 | D18F2x274_dct[3:0]: DRAM DQ Mask Low                             |
| 393 | D18F2x9C_x0002_0035_dct[3:0]: US Mailbox 2 Protocol               | 431 | D18F2x278_dct[3:0]: DRAM DQ Mask High                            |
| 393 | D18F2x9C_x0002_005B_dct[3:0]: D3_EVNTMERR                         | 431 | D18F2x27C_dct[3:0]: DRAM ECC and EDC Mask                        |
| 393 | D18F2x9C_x0002_005F_dct[3:0]: Misc Phy Status                     | 432 | D18F2x28C_dct[3:0]: DRAM Command 2                               |
| 393 | D18F2x9C_x0002_0060_dct[3:0]: Memreset Control                    | 432 | D18F2x290_dct[3:0]: DRAM Status 3                                |
| 394 | D18F2x9C_x0[1:0]02_0080_dct[3:0]: PMU CLK Divider                 | 433 | D18F2x294_dct[3:0]: DRAM Status 4                                |
| 394 | D18F2x9C_x0002_0087_dct[3:0]: Disable Calibration                 | 433 | D18F2x298_dct[3:0]: DRAM Status 5                                |
| 396 | D18F2x9C_x0002_0088_dct[3:0]: CalRate                             | 433 | D18F2x29C_dct[3:0]: DRAM Status 6                                |
| 396 | D18F2x9C_x0002_0089_dct[3:0]: PllLockTime                         | 434 | D18F2x2E0_dct[3:0]: Memory P-state Control and Status            |
| 396 | D18F2x9C_x0002_0093_dct[3:0]: PllRegWaitTime                      | 434 | D18F2x2E8_dct[3:0]_mp[1:0]: MRS Buffer                           |
| 396 | D18F2x9C_x0002_0097_dct[3:0]: CalBusy                             | 435 | D18F2x2EC_dct[3:0]_mp[1:0]: MRS Buffer                           |
| 396 | D18F2x9C_x0002_0098_dct[3:0]: Cal Misc 2                          | 435 | D18F2x2F0_dct[3:0]_mp[1:0]: DRAM Controller Misc 3               |
| 397 | D18F2x9C_x0002_0099_dct[3:0]: PMU Reset                           | 435 | D18F2x400_dct[3:0]: GMC to DCT Control 0                         |
| 397 | D18F2x[B,0]9C_x0005_[5BFF:4000]_dct[3:0]: PMU IC SRAM             | 435 | D18F2x404_dct[3:0]: GMC to DCT Control 1                         |
| 398 | D18F2x9C_x0005_[0BFF:0000]_dct[3:0]: PMU SRAM Message Block       | 436 | D18F2x408_dct[3:0]: GMC to DCT Control 2                         |
| 398 | D18F2x9C_x00F4_00E[7:0]_dct[3:0]: Odt Pattern                     | 437 | D18F2x420_dct[3:0]: GMC to DCT FIFO Config 1                     |
| 398 | D18F2x9C_x00F4_00FD_dct[3:0]: Phy CKE control                     | 437 | D18F2xB60_dct[3:0]: DRAM Control 0                               |
| 398 | D18F2x9C_x0007_0015_dct[3:0]: Lane to CRC Map0                    | 438 | D18F2xB64_dct[3:0]: Data Scramble Key                            |
| 399 | D18F2x9C_x0007_0016_dct[3:0]: Lane to CRC Map1                    | 439 | D18F3x00: Device/Vendor ID                                       |
| 399 | D18F2x9C_x0009_0000_dct[3:0]: ABIT Enable                         | 439 | D18F3x04: Status/Command                                         |
| 399 | D18F2x9C_x0009_000E_dct[3:0]: Global Control Slave                | 439 | D18F3x08: Class Code/Revision ID                                 |
| 399 | D18F2x9C_x0009_004A_dct[3:0]: Rx Control 1                        | 439 | D18F3x0C: Header Type                                            |
| 400 | D18F2x9C_x00FF_000D_dct[3:0]: Phy Clock Control                   | 439 | D18F3x34: Capability Pointer                                     |
| 401 | D18F2xA4: DRAM Controller Temperature Throttle                    | 439 | D18F3x40: MCA NB Control                                         |
| 402 | D18F2xA8_dct[3:0]: DRAM Controller Miscellaneous 2                | 441 | D18F3x44: MCA NB Configuration                                   |
| 404 | D18F2xAC: DRAM Controller Temperature Status                      | 444 | D18F3x48: MCA NB Status Low                                      |
| 404 | D18F2xF8: P-state Power Information 1                             | 444 | D18F3x4C: MCA NB Status High                                     |
| 404 | D18F2xFC: P-state Power Information 2                             | 444 | D18F3x50: MCA NB Address Low                                     |
| 405 | D18F2x104: P-state Power Information 3                            | 444 | D18F3x54: MCA NB Address High                                    |
| 405 | D18F2x110: DRAM Controller Select Low                             | 444 | D18F3x58: Scrub Rate Control                                     |
| 406 | D18F2x114: DRAM Controller Select High                            | 445 | D18F3x5C: DRAM Scrub Address Low                                 |
| 407 | D18F2x118: Memory Controller Configuration Low                    | 446 | D18F3x60: DRAM Scrub Address High                                |
| 408 | D18F2x11C: Memory Controller Configuration High                   | 446 | D18F3x64: Hardware Thermal Control (HTC)                         |
| 411 | D18F2x1B0: Extended Memory Controller Configuration Low           | 447 | D18F3x68: Software P-state Limit                                 |
| 413 | D18F2x1B4: Extended Memory Controller Configuration High Register | 448 | D18F3x6C: Data Buffer Count                                      |
| 414 | D18F2x1BC_dct[3:0]: DRAM CKE to CS Map                            | 448 | D18F3x70: SRI to XBAR Command Buffer Count                       |
| 415 | D18F2x200_dct[3:0]_mp[1:0]: DDR3 DRAM Timing 0                    | 449 | D18F3x74: XBAR to SRI Command Buffer Count                       |
| 416 | D18F2x204_dct[3:0]_mp[1:0]: DDR3 DRAM Timing 1                    | 451 | D18F3x78: MCT to XBAR Buffer Count                               |
| 417 | D18F2x208_dct[3:0]: DDR3 DRAM Timing 2                            | 452 | D18F3x7C: Free List Buffer Count                                 |
| 417 | D18F2x20C_dct[3:0]_mp[1:0]: DDR3 DRAM Timing 3                    | 452 | D18F3x[84:80]: ACPI Power State Control                          |
| 418 | D18F2x210_dct[3:0]_nbp[3:0]: DRAM NB P-state                      | 455 | D18F3x88: NB Configuration 1 Low (NB_CFG1_LO)                    |
| 418 | D18F2x214_dct[3:0]_mp[1:0]: DDR3 DRAM Timing 4                    | 455 | D18F3x8C: NB Configuration 1 High (NB_CFG1_HI)                   |
| 419 | D18F2x218_dct[3:0]_mp[1:0]: DDR3 DRAM Timing 5                    | 455 | D18F3xA0: Power Control Miscellaneous                            |
| 420 | D18F2x21C_dct[3:0]_mp[1:0]: DDR3 DRAM Timing 6                    | 456 | D18F3xA4: Reported Temperature Control                           |
| 421 | D18F2x220_dct[3:0]: DDR3 DRAM Timing 7                            | 458 | D18F3xA8: Pop Up and Down P-states                               |
| 421 | D18F2x224_dct[3:0]: DDR3 DRAM Timing 8                            |     |                                                                  |

|     |                                                                    |     |                                                            |
|-----|--------------------------------------------------------------------|-----|------------------------------------------------------------|
| 458 | D18F3xB8: NB Array Address                                         | 493 | D18F5x170: Northbridge P-state Control                     |
| 458 | D18F3xBC: NB Array Data Port                                       | 494 | D18F5x174: Northbridge P-state Status                      |
| 458 | D18F3xBC_x8: DRAM ECC                                              | 495 | D18F5x178: Northbridge Fusion Configuration                |
| 459 | D18F3xD4: Clock Power/Timing Control 0                             | 496 | D18F5x17C: Miscellaneous Voltages                          |
| 461 | D18F3xD8: Clock Power/Timing Control 1                             | 496 | D18F5x188: Clock Power/Timing Control 5                    |
| 462 | D18F3xDC: Clock Power/Timing Control 2                             | 497 | D18F5x18C: Clock Power/Timing Control 6                    |
| 464 | D18F3xE4: Thermtrip Status                                         | 497 | D18F5x194: Name String Address Port                        |
| 464 | D18F3xE8: Northbridge Capabilities                                 | 497 | D18F5x198: Name String Data Port                           |
| 465 | D18F3xFC: CUID Family/Model/Stepping                               | 497 | D18F5x198_x[B:0]: Name String Data                         |
| 465 | D18F3x138: DCT0 Bad Symbol Identification                          | 498 | D18F5x240: ECC Exclusion Base Address Low                  |
| 466 | D18F3x13C: DCT1 Bad Symbol Identification                          | 498 | D18F5x244: ECC Exclusion Base Address High                 |
| 466 | D18F3x140: SRI to XCS Token Count                                  | 498 | D18F5x248: ECC Exclusion Limit Address Low                 |
| 467 | D18F3x144: MCT to XCS Token Count                                  | 498 | D18F5x24C: ECC Exclusion Limit Address High                |
| 467 | D18F3x1[54:48]: Link to XCS Token Count                            | 499 | D18F5x260: Clock Power/Timing Control 8                    |
| 468 | D18F3x160: NB Machine Check Misc (DRAM Thresholding) 0 (MC4_MISC0) | 500 | NBIOAPICx00: IO Register Select                            |
| 469 | D18F3x168: NB Machine Check Misc (Link Thresholding) 1 (MC4_MISC1) | 500 | NBIOAPICx10: IO Window                                     |
| 469 | D18F3x17C: Extended Freelist Buffer Count                          | 500 | NBIOAPICx10_x00: IOAPIC ID                                 |
| 470 | D18F3x180: Extended NB MCA Configuration                           | 500 | NBIOAPICx10_x01: IOAPIC Version                            |
| 472 | D18F3x188: NB Configuration 2                                      | 500 | NBIOAPICx10_x02: IOAPIC Arbitration                        |
| 472 | D18F3x190: Downcore Control                                        | 501 | NBIOAPICx10_x[4E:10:step2]: Redirection Table Entry [31:0] |
| 472 | D18F3x1A0: Core Interface Buffer Count                             | 501 | NBIOAPICx20: IRQ Pin Assertion                             |
| 473 | D18F3x1CC: IBS Control                                             | 501 | NBIOAPICx40: EOI                                           |
| 474 | D18F3x1FC: Product Information Register 1                          | 502 | IOMMUx00: Device Table Base Address Low                    |
| 474 | D18F3x200: Performance Mode Control Register                       | 502 | IOMMUx04: Device Table Base Address High                   |
| 474 | D18F3x238: DCT2 Bad Symbol Identification                          | 502 | IOMMUx08: Command Buffer Base Address Low                  |
| 474 | D18F3x23C: DCT3 Bad Symbol Identification                          | 502 | IOMMUx0C: Command Buffer Base Address High                 |
| 474 | D18F3x2B4: DCT and Fuse Power Gate Control                         | 503 | IOMMUx10: Event Log Base Address Low                       |
| 476 | D18F4x00: Device/Vendor ID                                         | 503 | IOMMUx14: Event Log Base Address High                      |
| 476 | D18F4x04: Status/Command                                           | 503 | IOMMUx18: Control Low                                      |
| 476 | D18F4x08: Class Code/Revision ID                                   | 505 | IOMMUx20: Exclusion Range Base Low                         |
| 476 | D18F4x0C: Header Type                                              | 505 | IOMMUx24: Exclusion Range Base High                        |
| 476 | D18F4x34: Capabilities Pointer                                     | 506 | IOMMUx28: Exclusion Range Limit Low                        |
| 477 | D18F4x110: Sample and Residency Timers                             | 506 | IOMMUx2C: Exclusion Range Limit High                       |
| 477 | D18F4x11[C:8]: C-state Control                                     | 506 | IOMMUx30: Extended Feature Low                             |
| 480 | D18F4x124: C-state Interrupt Control                               | 507 | IOMMUx34: Extended Feature High                            |
| 480 | D18F4x128: C-state Policy Control 1                                | 508 | IOMMUx38: PPR Log Base Address Low                         |
| 481 | D18F4x13C: SMU P-state Control                                     | 508 | IOMMUx3C: PPR Log Base Address High                        |
| 482 | D18F4x15C: Core Performance Boost Control                          | 508 | IOMMUx40: Hardware Error Upper Low                         |
| 482 | D18F4x164: Fixed Errata                                            | 508 | IOMMUx44: Hardware Error Upper High                        |
| 483 | D18F4x16C: APM TDP Control                                         | 509 | IOMMUx48: Hardware Error Lower Low                         |
| 483 | D18F4x1C0: Node Cac Register 1                                     | 509 | IOMMUx4C: Hardware Error Lower High                        |
| 484 | D18F4x250: TDP Limit 8                                             | 509 | IOMMUx50: Hardware Error Status                            |
| 485 | D18F5x00: Device/Vendor ID                                         | 509 | IOMMUx[78,70,68,60]: SMI Filter Low                        |
| 485 | D18F5x04: Status/Command                                           | 510 | IOMMUx[7C,74,6C,64]: SMI Filter High                       |
| 485 | D18F5x08: Class Code/Revision ID                                   | 510 | IOMMUx2000: Command Buffer Head Pointer                    |
| 485 | D18F5x0C: Header Type                                              | 510 | IOMMUx2008: Command Buffer Tail Pointer                    |
| 485 | D18F5x34: Capabilities Pointer                                     | 510 | IOMMUx2010: Event Log Head Pointer                         |
| 485 | D18F5x[70,60,50,40]: Northbridge Performance Event Select Low      | 511 | IOMMUx2018: Event Log Tail Pointer                         |
| 486 | D18F5x[74,64,54,44]: Northbridge Performance Event Select High     | 511 | IOMMUx2020: Status                                         |
| 486 | D18F5x[78,68,58,48]: Northbridge Performance Event Counter Low     | 512 | IOMMUx2030: PPR Log Head Pointer                           |
| 486 | D18F5x[7C,6C,5C,4C]: Northbridge Performance Event Counter High    | 513 | IOMMUx2038: PPR Log Tail Pointer                           |
| 486 | D18F5x80: Compute Unit Status 1                                    | 513 | IOMMUx4000: Counter Configuration                          |
| 487 | D18F5x84: Northbridge Capabilities 2                               | 513 | IOMMUx4008: Counter PASID Bank Lock Low                    |
| 487 | D18F5x88: NB Configuration 4 (NB_CFG4)                             | 514 | IOMMUx400C: Counter PASID Bank Lock High                   |
| 488 | D18F5x8C: NB Configuration 5 (NB_CFG5)                             | 514 | IOMMUx4010: Domain Bank Lock Low                           |
| 488 | D18F5xE0: Processor TDP Running Average                            | 514 | IOMMUx4014: Domain Bank Lock High                          |
| 488 | D18F5xE8: TDP Limit 3                                              | 514 | IOMMUx4018: DeviceID Bank Lock Low                         |
| 488 | D18F5xEC: Load Step Throttle Control                               | 514 | IOMMUx401C: DeviceID Bank Lock High                        |
| 489 | D18F5x128: Clock Power/Timing Control 3                            | 514 | IOMMUx4[1,0][3:0]00: Counter Low                           |
| 490 | D18F5x12C: Clock Power/Timing Control 4                            | 515 | IOMMUx4[1,0][3:0]04: Counter High                          |
| 491 | D18F5x16[C:0]: Northbridge P-state [3:0]                           | 515 | IOMMUx4[1,0][3:0]08: Counter Source                        |
|     |                                                                    | 515 | IOMMUx4[1,0][3:0]10: PASID Match Low                       |
|     |                                                                    | 516 | IOMMUx4[1,0][3:0]14: PASID Match High                      |

|     |                                                                              |     |                                                                              |
|-----|------------------------------------------------------------------------------|-----|------------------------------------------------------------------------------|
| 516 | IOMMUx4[1,0][3:0]18: Domain Match Low                                        | 537 | CPUID Fn0000_000D_EAX_x0: Processor Extended State Enumeration (ECX=0)       |
| 517 | IOMMUx4[1,0][3:0]1C: Domain Match High                                       | 537 | CPUID Fn0000_000D_EBX_x0: Processor Extended State Enumeration (ECX=0)       |
| 517 | IOMMUx4[1,0][3:0]20: DeviceID Match Low                                      | 537 | CPUID Fn0000_000D_ECX_x0: Processor Extended State Enumeration (ECX=0)       |
| 517 | IOMMUx4[1,0][3:0]24: DeviceID Match High                                     | 537 | CPUID Fn0000_000D_EDX_x0: Processor Extended State Enumeration (ECX=0)       |
| 518 | IOMMUx4[1,0][3:0]28: Counter Report Low                                      | 537 | CPUID Fn0000_000D_EAX_x1: Processor Extended State Enumeration (ECX=1)       |
| 518 | IOMMUx4[1,0][3:0]2C: Counter Report High                                     | 538 | CPUID Fn0000_000D_E[D,C,B]X_x1: Processor Extended State Enumeration (ECX=1) |
| 520 | APIC20: APIC ID                                                              | 538 | CPUID Fn0000_000D_EAX_x2: Processor Extended State Enumeration (ECX=2)       |
| 520 | APIC30: APIC Version                                                         | 538 | CPUID Fn0000_000D_EBX_x2: Processor Extended State Enumeration (ECX=2)       |
| 520 | APIC80: Task Priority (TPR)                                                  | 538 | CPUID Fn0000_000D_ECX_x2: Processor Extended State Enumeration (ECX=2)       |
| 520 | APIC90: Arbitration Priority (APR)                                           | 538 | CPUID Fn0000_000D_EDX_x2: Processor Extended State Enumeration (ECX=2)       |
| 521 | APICA0: Processor Priority (PPR)                                             | 538 | CPUID Fn0000_000D_EAX_x3E: Processor Extended State Enumeration (ECX=62)     |
| 521 | APICB0: End of Interrupt                                                     | 538 | CPUID Fn0000_000D_EBX_x3E: Processor Extended State Enumeration (ECX=62)     |
| 521 | APICC0: Remote Read                                                          | 539 | CPUID Fn0000_000D_ECX_x3E: Processor Extended State Enumeration (ECX=62)     |
| 521 | APICD0: Logical Destination (LDR)                                            | 539 | CPUID Fn0000_000D_EDX_x3E: Processor Extended State Enumeration (ECX=62)     |
| 521 | APICE0: Destination Format                                                   | 539 | CPUID Fn8000_0000_EAX: Largest Extended Function Number                      |
| 522 | APICF0: Spurious-Interrupt Vector (SVR)                                      | 539 | CPUID Fn8000_0000_E[D,C,B]X: Processor Vendor                                |
| 522 | APIC[170:100]: In-Service (ISR)                                              | 539 | CPUID Fn8000_0001_EAX: Family, Model, Stepping Identifiers                   |
| 522 | APIC[1F0:180]: Trigger Mode (TMR)                                            | 540 | CPUID Fn8000_0001_EBX: BrandId Identifier                                    |
| 523 | APIC[270:200]: Interrupt Request (IRR)                                       | 540 | CPUID Fn8000_0001_ECX: Feature Identifiers                                   |
| 523 | APIC280: Error Status                                                        | 541 | CPUID Fn8000_0001_EDX: Feature Identifiers                                   |
| 524 | APIC300: Interrupt Command Low (ICR Low)                                     | 542 | CPUID Fn8000_000[4:2]_E[D,C,B,A]X: Processor Name String Identifier          |
| 525 | APIC310: Interrupt Command High (ICR High)                                   | 543 | CPUID Fn8000_0005_EAX: L1 TLB 2M/4M Identifiers                              |
| 525 | APIC320: LVT Timer                                                           | 543 | CPUID Fn8000_0005_EBX: L1 TLB 4K Identifiers                                 |
| 526 | APIC330: LVT Thermal Sensor                                                  | 544 | CPUID Fn8000_0005_ECX: L1 Data Cache Identifiers                             |
| 526 | APIC340: LVT Performance Monitor                                             | 544 | CPUID Fn8000_0005_EDX: L1 Instruction Cache Identifiers                      |
| 526 | APIC3[60:50]: LVT LINT[1:0]                                                  | 544 | CPUID Fn8000_0006_EAX: L2 TLB 2M/4M Identifiers                              |
| 527 | APIC370: LVT Error                                                           | 545 | CPUID Fn8000_0006_EBX: L2 TLB 4K Identifiers                                 |
| 527 | APIC380: Timer Initial Count                                                 | 545 | CPUID Fn8000_0006_ECX: L2 Cache Identifiers                                  |
| 527 | APIC390: Timer Current Count                                                 | 546 | CPUID Fn8000_0006_EDX: L3 Cache Identifiers                                  |
| 527 | APIC3E0: Timer Divide Configuration                                          | 546 | CPUID Fn8000_0007_EAX: Processor Feedback Capabilities                       |
| 528 | APIC400: Extended APIC Feature                                               | 546 | CPUID Fn8000_0007_EBX: RAS Capabilities                                      |
| 528 | APIC410: Extended APIC Control                                               | 547 | CPUID Fn8000_0007_ECX: Advanced Power Management Information                 |
| 529 | APIC420: Specific End Of Interrupt                                           | 547 | CPUID Fn8000_0007_EDX: Advanced Power Management Information                 |
| 529 | APIC[4F0:480]: Interrupt Enable                                              | 547 | CPUID Fn8000_0008_EAX: Long Mode Address Size Identifiers                    |
| 529 | APIC[530:500]: Extended Interrupt [3:0] Local Vector Table                   | 548 | CPUID Fn8000_0008_EBX: Reserved                                              |
| 530 | CPUID Fn0000_0000_EAX: Processor Vendor and Largest Standard Function Number | 548 | CPUID Fn8000_0008_ECX: Size Identifiers                                      |
| 530 | CPUID Fn0000_0000_E[D,C,B]X: Processor Vendor                                | 548 | CPUID Fn8000_0008_EDX: Reserved                                              |
| 531 | CPUID Fn0000_0001_EAX: Family, Model, Stepping Identifiers                   | 548 | CPUID Fn8000_0009: Reserved                                                  |
| 531 | CPUID Fn0000_0001_EBX: LocalApicId, LogicalProcessorCount, CLFlush           | 549 | CPUID Fn8000_000A_EAX: SVM Revision and Feature Identification               |
| 531 | CPUID Fn0000_0001_ECX: Feature Identifiers                                   | 549 | CPUID Fn8000_000A_EBX: SVM Revision and Feature Identification               |
| 533 | CPUID Fn0000_0001_EDX: Feature Identifiers                                   | 549 | CPUID Fn8000_000A_ECX: SVM Revision and Feature Identification               |
| 534 | CPUID Fn0000_000[4:2]: Reserved                                              | 549 | CPUID Fn8000_000A_EDX: SVM Revision and Feature Identification               |
| 534 | CPUID Fn0000_0005_EAX: Monitor/MWait                                         | 550 | CPUID Fn8000_00[18:0B]: Reserved                                             |
| 534 | CPUID Fn0000_0005_EBX: Monitor/MWait                                         | 550 | CPUID Fn8000_0019_EAX: L1 TLB 1G Identifiers                                 |
| 534 | CPUID Fn0000_0005_ECX: Monitor/MWait                                         | 551 | CPUID Fn8000_0019_EBX: L2 TLB 1G Identifiers                                 |
| 534 | CPUID Fn0000_0005_EDX: Monitor/MWait                                         | 551 | CPUID Fn8000_0019_E[D,C]X: Reserved                                          |
| 534 | CPUID Fn0000_0006_EAX: Thermal and Power Management                          | 551 | CPUID Fn8000_001A_EAX: Performance Optimization Identifiers                  |
| 535 | CPUID Fn0000_0006_EBX: Thermal and Power Management                          | 551 | CPUID Fn8000_001A_E[D,C,B]X: Reserved                                        |
| 535 | CPUID Fn0000_0006_ECX: Thermal and Power Management                          |     |                                                                              |
| 535 | CPUID Fn0000_0006_EDX: Thermal and Power Management                          |     |                                                                              |
| 535 | CPUID Fn0000_0007_EAX_x0: Structured Extended Feature Identifiers (ECX=0)    |     |                                                                              |
| 535 | CPUID Fn0000_0007_EBX_x0: Structured Extended Feature Identifiers (ECX=0)    |     |                                                                              |
| 536 | CPUID Fn0000_0007_ECX_x0: Structured Extended Feature Identifiers (ECX=0)    |     |                                                                              |
| 536 | CPUID Fn0000_0007_EDX_x0: Structured Extended Feature Identifiers (ECX=0)    |     |                                                                              |
| 536 | CPUID Fn0000_000[A:8]: Reserved                                              |     |                                                                              |
| 536 | CPUID Fn0000_000B: Reserved                                                  |     |                                                                              |
| 536 | CPUID Fn0000_000C: Reserved                                                  |     |                                                                              |

|     |                                                                          |     |                                                                                  |
|-----|--------------------------------------------------------------------------|-----|----------------------------------------------------------------------------------|
| 551 | CPUID Fn8000_001B_EAX: Instruction Based Sampling Identifiers            | 590 | MSR0000_040C: MC3 Machine Check Control (MC3_CTL)                                |
| 552 | CPUID Fn8000_001B_E[D,C,B]X: Instruction Based Sampling Identifiers      | 590 | MSR0000_040D: MC3 Machine Check Status (MC3_STATUS)                              |
| 552 | CPUID Fn8000_001C_EAX: Lightweight Profiling Capabilities 0              | 590 | MSR0000_040E: MC3 Machine Check Address (MC3_ADDR)                               |
| 553 | CPUID Fn8000_001C_EBX: Lightweight Profiling Capabilities 0              | 590 | MSR0000_040F: MC3 Machine Check Miscellaneous (MC3_MISC)                         |
| 553 | CPUID Fn8000_001C_ECX: Lightweight Profiling Capabilities 0              | 590 | MSR0000_0410: MC4 Machine Check Control (MC4_CTL)                                |
| 553 | CPUID Fn8000_001C_EDX: Lightweight Profiling Capabilities 0              | 592 | MSR0000_0411: MC4 Machine Check Status (MC4_STATUS)                              |
| 554 | CPUID Fn8000_001D_EAX_x0: Cache Properties                               | 595 | MSR0000_0412: MC4 Machine Check Address (MC4_ADDR)                               |
| 555 | CPUID Fn8000_001D_EAX_x1: Cache Properties                               | 598 | MSR0000_0413: NB Machine Check Misc 4 (DRAM Thresholding) 0 (MC4_MISC0)          |
| 555 | CPUID Fn8000_001D_EAX_x2: Cache Properties                               | 600 | MSR0000_0414: MC5 Machine Check Control (MC5_CTL)                                |
| 556 | CPUID Fn8000_001D_EAX_x3: Cache Properties                               | 600 | MSR0000_0415: MC5 Machine Check Status (MC5_STATUS)                              |
| 556 | CPUID Fn8000_001D_EBX_x0: Cache Properties                               | 603 | MSR0000_0416: MC5 Machine Check Address (MC5_ADDR)                               |
| 556 | CPUID Fn8000_001D_EBX_x1: Cache Properties                               | 604 | MSR0000_0417: MC5 Machine Check Miscellaneous (MC5_MISC)                         |
| 556 | CPUID Fn8000_001D_EBX_x2: Cache Properties                               | 604 | MSR0000_0418: MC6 Machine Check Control (MC6_CTL)                                |
| 557 | CPUID Fn8000_001D_EBX_x3: Cache Properties                               | 605 | MSR0000_0419: MC6 Machine Check Status (MC6_STATUS)                              |
| 557 | CPUID Fn8000_001D_ECX_x0: Cache Properties                               | 606 | MSR0000_041A: MC6 Machine Check Address (MC6_ADDR)                               |
| 557 | CPUID Fn8000_001D_ECX_x1: Cache Properties                               | 606 | MSR0000_041B: MC6 Machine Check Miscellaneous (MC6_MISC)                         |
| 558 | CPUID Fn8000_001D_ECX_x2: Cache Properties                               | 607 | MSRC000_0080: Extended Feature Enable (EFER)                                     |
| 558 | CPUID Fn8000_001D_ECX_x3: Cache Properties                               | 607 | MSRC000_0081: SYSCALL Target Address (STAR)                                      |
| 558 | CPUID Fn8000_001D_EDX_x0: Cache Properties                               | 607 | MSRC000_0082: Long Mode SYSCALL Target Address (STAR64)                          |
| 558 | CPUID Fn8000_001D_EDX_x1: Cache Properties                               | 608 | MSRC000_0083: Compatibility Mode SYSCALL Target Address (STARCOMPAT)             |
| 558 | CPUID Fn8000_001D_EDX_x2: Cache Properties                               | 608 | MSRC000_0084: SYSCALL Flag Mask (SYSCALL_FLAG_MASK)                              |
| 559 | CPUID Fn8000_001D_EDX_x3: Cache Properties                               | 608 | MSRC000_00E7: Read-Only Max Performance Frequency Clock Count (MPerfReadOnly)    |
| 559 | CPUID Fn8000_001E_EAX: Extended APIC ID                                  | 608 | MSRC000_00E8: Read-Only Actual Performance Frequency Clock Count (APerfReadOnly) |
| 559 | CPUID Fn8000_001E_EBX: Compute Unit Identifiers                          | 608 | MSRC000_0100: FS Base (FS_BASE)                                                  |
| 559 | CPUID Fn8000_001E_ECX: Node Identifiers                                  | 609 | MSRC000_0101: GS Base (GS_BASE)                                                  |
| 559 | CPUID Fn8000_001E_EDX: Reserved                                          | 609 | MSRC000_0102: Kernel GS Base (KernelGSbase)                                      |
| 561 | MSR0000_0000: Load-Store MCA Address                                     | 609 | MSRC000_0103: Auxiliary Time Stamp Counter (TSC_AUX)                             |
| 561 | MSR0000_0001: Load-Store MCA Status                                      | 609 | MSRC000_0104: Time Stamp Counter Ratio (TscRateMsr)                              |
| 561 | MSR0000_0010: Time Stamp Counter (TSC)                                   | 610 | MSRC000_0105: Lightweight Profile Configuration (LWP_CFG)                        |
| 561 | MSR0000_001B: APIC Base Address (APIC_BAR)                               | 610 | MSRC000_0106: Lightweight Profile Control Block Address (LWP_CBADDR)             |
| 562 | MSR0000_002A: Cluster ID (EBL_CR_POWERON)                                | 611 | MSRC000_0408: NB Machine Check Misc 4 (Link Thresholding) 1 (MC4_MISC1)          |
| 562 | MSR0000_00E7: Max Performance Frequency Clock Count (MPERF)              | 613 | MSRC000_0409: Reserved                                                           |
| 562 | MSR0000_00E8: Actual Performance Frequency Clock Count (APERF)           | 614 | MSRC000_040[F:A]: Reserved                                                       |
| 562 | MSR0000_00FE: MTRR Capabilities (MTRRcap)                                | 615 | MSRC001_00[03:00]: Performance Event Select (PERF_CTL[3:0])                      |
| 562 | MSR0000_0174: SYSENTER CS (SYSENTER_CS)                                  | 615 | MSRC001_00[07:04]: Performance Event Counter (PERF_CTR[3:0])                     |
| 563 | MSR0000_0175: SYSENTER ESP (SYSENTER_ESP)                                | 615 | MSRC001_0010: System Configuration (SYS_CFG)                                     |
| 563 | MSR0000_0176: SYSENTER EIP (SYSENTER_EIP)                                | 616 | MSRC001_0015: Hardware Configuration (HWCRC)                                     |
| 563 | MSR0000_0179: Global Machine Check Capabilities (MCG_CAP)                | 618 | MSRC001_00[18,16]: IO Range Base (IORR_BASE[1:0])                                |
| 563 | MSR0000_017A: Global Machine Check Status (MCG_STAT)                     | 619 | MSRC001_00[19,17]: IO Range Mask (IORR_MASK[1:0])                                |
| 564 | MSR0000_017B: Global Machine Check Exception Reporting Control (MCG_CTL) | 619 | MSRC001_001A: Top Of Memory (TOP_MEM)                                            |
| 564 | MSR0000_01D9: Debug Control (DBG_CTL_MSR)                                | 619 | MSRC001_001D: Top Of Memory 2 (TOM2)                                             |
| 564 | MSR0000_01DB: Last Branch From IP (BR_FROM)                              | 619 | MSRC001_001F: Northbridge Configuration 1 (NB_CFG1)                              |
| 564 | MSR0000_01DC: Last Branch To IP (BR_TO)                                  | 621 | MSRC001_0022: Machine Check Exception Redirection                                |
| 565 | MSR0000_01DD: Last Exception From IP                                     | 621 | MSRC001_00[35:30]: Processor Name String                                         |
| 565 | MSR0000_01DE: Last Exception To IP                                       | 622 | MSRC001_003E: Hardware Thermal Control (HTC)                                     |
| 565 | MSR0000_020[F:0]: Variable-Size MTRRs Base/Mask                          | 622 | MSRC001_0044: DC Machine Check Control Mask (MC0_CTL_MASK)                       |
| 566 | MSR0000_02[6F:68,59:58,50]: Fixed-Size MTRRs                             | 623 | MSRC001_0045: IC Machine Check Control Mask (MC1_CTL_MASK)                       |
| 568 | MSR0000_0277: Page Attribute Table (PAT)                                 | 624 | MSRC001_0046: BU Machine Check Control Mask (MC2_CTL_MASK)                       |
| 569 | MSR0000_02FF: MTRR Default Memory Type (MTRRdefType)                     | 624 | MSRC001_0047: Reserved (MC3_CTL_MASK)                                            |
| 569 | MSR0000_0400: MC0 Machine Check Control (MC0_CTL)                        | 624 | MSRC001_0048: NB Machine Check Control Mask (MC4_CTL_MASK)                       |
| 570 | MSR0000_0401: MC0 Machine Check Status (MC0_STATUS)                      | 625 | MSRC001_0049: EX Machine Check Control Mask (MC5_CTL_MASK)                       |
| 573 | MSR0000_0402: MC0 Machine Check Address (MC0_ADDR)                       |     |                                                                                  |
| 574 | MSR0000_0403: MC0 Machine Check Miscellaneous (MC0_MISC)                 |     |                                                                                  |
| 575 | MSR0000_0404: MC1 Machine Check Control (MC1_CTL)                        |     |                                                                                  |
| 576 | MSR0000_0405: MC1 Machine Check Status (MC1_STATUS)                      |     |                                                                                  |
| 579 | MSR0000_0406: MC1 Machine Check Address (MC1_ADDR)                       |     |                                                                                  |
| 582 | MSR0000_0407: MC1 Machine Check Miscellaneous (MC1_MISC)                 |     |                                                                                  |
| 583 | MSR0000_0408: MC2 Machine Check Control (MC2_CTL)                        |     |                                                                                  |
| 583 | MSR0000_0409: MC2 Machine Check Status (MC2_STATUS)                      |     |                                                                                  |
| 588 | MSR0000_040A: MC2 Machine Check Address (MC2_ADDR)                       |     |                                                                                  |
| 589 | MSR0000_040B: MC2 Machine Check Miscellaneous (MC2_MISC)                 |     |                                                                                  |

|     |                                                                                |     |                                                                            |
|-----|--------------------------------------------------------------------------------|-----|----------------------------------------------------------------------------|
| 625 | MSRC001_004A: FP Machine Check Control Mask (MC6_CTL_MASK)                     | 661 | MSRC001_103A: IBS Control                                                  |
| 626 | MSRC001_00[53:50]: IO Trap (SMI_ON_IO_TRAP[3:0])                               | 662 | MSRC001_103B: IBS Branch Target Address (BP_IBSTGT_RIP)                    |
| 627 | MSRC001_0054: IO Trap Control (SMI_ON_IO_TRAP_CTL_STS)                         | 662 | MSRC001_1090: Processor Feedback Constants 0                               |
| 627 | MSRC001_0055: Interrupt Pending                                                | 664 | PMCx000: FPU Pipe Assignment                                               |
| 628 | MSRC001_0056: SMI Trigger IO Cycle                                             | 664 | PMCx001: FP Scheduler Empty                                                |
| 628 | MSRC001_0058: MMIO Configuration Base Address                                  | 664 | PMCx003: Retired SSE/AVX Operations                                        |
| 629 | MSRC001_0060: BIST Results                                                     | 665 | PMCx004: Number of Move Elimination and Scalar Op Optimization             |
| 629 | MSRC001_0061: P-state Current Limit                                            | 665 | PMCx005: Retired Serializing Ops                                           |
| 630 | MSRC001_0062: P-state Control                                                  | 665 | PMCx006: Number of Cycles that a Bottom-Execute uop is in the FP Scheduler |
| 630 | MSRC001_0063: P-state Status                                                   | 665 | PMCx020: Segment Register Loads                                            |
| 630 | MSRC001_00[6B:64]: P-state [7:0]                                               | 666 | PMCx021: Pipeline Restart Due to Self-Modifying Code                       |
| 632 | MSRC001_0070: COFVID Control                                                   | 666 | PMCx022: Pipeline Restart Due to Probe Hit                                 |
| 633 | MSRC001_0071: COFVID Status                                                    | 666 | PMCx023: Load Queue/Store Queue Full                                       |
| 634 | MSRC001_0073: C-state Base Address                                             | 666 | PMCx024: Locked Operations                                                 |
| 634 | MSRC001_0074: CPU Watchdog Timer (CpuWdtCfg)                                   | 666 | PMCx026: Retired CLFLUSH Instructions                                      |
| 635 | MSRC001_0111: SMM Base Address (SMM_BASE)                                      | 666 | PMCx027: Retired CPUID Instructions                                        |
| 635 | MSRC001_0112: SMM TSeg Base Address (SMMAddr)                                  | 666 | PMCx029: LS Dispatch                                                       |
| 636 | MSRC001_0113: SMM TSeg Mask (SMMMask)                                          | 667 | PMCx02A: Canceled Store to Load Forward Operations                         |
| 637 | MSRC001_0114: Virtual Machine Control (VM_CR)                                  | 667 | PMCx02B: SMIs Received                                                     |
| 638 | MSRC001_0115: IGNNE                                                            | 667 | PMCx030: Executed CLFLUSH Instructions                                     |
| 638 | MSRC001_0116: SMM Control (SMM_CTL)                                            | 667 | PMCx032: Misaligned Stores                                                 |
| 638 | MSRC001_0117: Virtual Machine Host Save Physical Address (VM_HSAVE_PA)         | 667 | PMCx034: FP +Load Buffer Stall                                             |
| 638 | MSRC001_0118: SVM Lock Key                                                     | 667 | PMCx035: STLF                                                              |
| 639 | MSRC001_011A: Local SMI Status                                                 | 667 | PMCx040: Data Cache Accesses                                               |
| 639 | MSRC001_0140: OS Visible Work-around MSR0 (OSVW_ID_Length)                     | 667 | PMCx041: Data Cache Misses                                                 |
| 639 | MSRC001_0141: OS Visible Work-around MSR1 (OSVW_Status)                        | 668 | PMCx042: Data Cache Refills from L2 or System                              |
| 639 | MSRC001_020[A,8,6,4,2,0]: Performance Event Select (PERF_CTL[5:0])             | 668 | PMCx043: Data Cache Refills from System                                    |
| 641 | MSRC001_020[B,9,7,5,3,1]: Performance Event Counter (PERF_CTR[5:0])            | 668 | PMCx045: Unified TLB Hit                                                   |
| 641 | MSRC001_024[6,4,2,0]: Northbridge Performance Event Select (NB_PERF_CTL[3:0])  | 669 | PMCx046: Unified TLB Miss                                                  |
| 642 | MSRC001_024[7,5,3,1]: Northbridge Performance Event Counter (NB_PERF_CTR[3:0]) | 669 | PMCx047: Misaligned Accesses                                               |
| 643 | MSRC001_0280: Performance Time Stamp Counter (CU_PTSC)                         | 669 | PMCx04B: Prefetch Instructions Dispatched                                  |
| 644 | MSRC001_1002: CPUID Features for CPUID Fn0000_0007_E[B,A]X_x0                  | 669 | PMCx052: Ineffective Software Prefetchs                                    |
| 644 | MSRC001_1003: Thermal and Power Management CPUID Features                      | 670 | PMCx060: Command Related to Victim Buffers                                 |
| 644 | MSRC001_1004: CPUID Features (Features)                                        | 670 | PMCx061: Command Related to Masked Operations                              |
| 646 | MSRC001_1005: Extended CPUID Features (ExtFeatures)                            | 670 | PMCx062: Command Related to Read Block Operations                          |
| 648 | MSRC001_101[B:9]: Address Mask For DR[3:1] Breakpoints                         | 670 | PMCx063: Command Related to Change to Dirty Operations                     |
| 648 | MSRC001_1020: Load-Store Configuration (LS_CFG)                                | 671 | PMCx064: Dram System Request                                               |
| 649 | MSRC001_1021: Instruction Cache Configuration (IC_CFG)                         | 671 | PMCx065: Memory Requests by Type                                           |
| 649 | MSRC001_1022: Data Cache Configuration (DC_CFG)                                | 671 | PMCx067: Data Cache Prefetches                                             |
| 649 | MSRC001_1023: Combined Unit Configuration (CU_CFG)                             | 671 | PMCx068: MAB Requests                                                      |
| 650 | MSRC001_1027: Address Mask For DR0 Breakpoints (DR0_ADDR_MASK)                 | 672 | PMCx069: MAB Wait Cycles                                                   |
| 650 | MSRC001_1028: Floating Point Configuration (FP_CFG)                            | 672 | PMCx06C: System Response by Coherence State                                |
| 651 | MSRC001_102A: Combined Unit Configuration 2 (CU_CFG2)                          | 672 | PMCx06D: Octwords Written to System                                        |
| 652 | MSRC001_102B: Combined Unit Configuration 3 (CU_CFG3)                          | 672 | PMCx075: Cache Cross-invalidates                                           |
| 654 | MSRC001_102F: Prefetch Throttling Configuration (CU_PFTCFG)                    | 673 | PMCx076: CPU Clocks not Halted                                             |
| 655 | MSRC001_1030: IBS Fetch Control (IbsFetchCtl)                                  | 673 | PMCx07D: Requests to L2 Cache                                              |
| 656 | MSRC001_1031: IBS Fetch Linear Address (IbsFetchLinAd)                         | 673 | PMCx07E: L2 Cache Misses                                                   |
| 656 | MSRC001_1032: IBS Fetch Physical Address (IbsFetchPhysAd)                      | 674 | PMCx07F: L2 Fill/Writeback                                                 |
| 657 | MSRC001_1033: IBS Execution Control (IbsOpCtl)                                 | 674 | PMCx165: Page Splintering                                                  |
| 658 | MSRC001_1034: IBS Op Logical Address (IbsOpRip)                                | 674 | PMCx16C: L2 Prefetcher Trigger Events                                      |
| 658 | MSRC001_1035: IBS Op Data (IbsOpData)                                          | 674 | PMCx080: Instruction Cache Fetches                                         |
| 659 | MSRC001_1036: IBS Op Data 2 (IbsOpData2)                                       | 675 | PMCx081: Instruction Cache Misses                                          |
| 659 | MSRC001_1037: IBS Op Data 3 (IbsOpData3)                                       | 675 | PMCx082: Instruction Cache Refills from L2                                 |
| 661 | MSRC001_1038: IBS DC Linear Address (IbsDcLinAd)                               | 675 | PMCx083: Instruction Cache Refills from System                             |
| 661 | MSRC001_1039: IBS DC Physical Address (IbsDcPhysAd)                            | 675 | PMCx084: L1 ITLB Miss, L2 ITLB Hit                                         |
|     |                                                                                | 675 | PMCx085: L1 ITLB Miss, L2 ITLB Miss                                        |
|     |                                                                                | 675 | PMCx086: Pipeline Restart Due to Instruction Stream Probe                  |
|     |                                                                                | 675 | PMCx087: Instruction Fetch Stall                                           |
|     |                                                                                | 676 | PMCx088: Return Stack Hits                                                 |
|     |                                                                                | 676 | PMCx089: Return Stack Overflows                                            |
|     |                                                                                | 676 | PMCx08B: Instruction Cache Victims                                         |
|     |                                                                                | 676 | PMCx08C: Instruction Cache Lines Invalidated                               |

676 PMCx099: ITLB Reloads  
 676 PMCx09A: ITLB Reloads Aborted  
 677 PMCx186: Uops Dispatched From Decoder  
 677 PMCx0C0: Retired Instructions  
 677 PMCx0C1: Retired uops  
 677 PMCx0C2: Retired Branch Instructions  
 677 PMCx0C3: Retired Mispredicted Branch Instructions  
 677 PMCx0C4: Retired Taken Branch Instructions  
 677 PMCx0C5: Retired Taken Branch Instructions Mispredicted  
 677 PMCx0C6: Retired Far Control Transfers  
 678 PMCx0C7: Retired Branch Resyncs  
 678 PMCx0C8: Retired Near Returns  
 678 PMCx0C9: Retired Near Returns Mispredicted  
 678 PMCx0CA: Retired Mispredicted Taken Branch Instructions due to Target Mismatch  
 678 PMCx0CB: Retired MMX/FP Instructions  
 678 PMCx0CD: Interrupts-Masked Cycles  
 678 PMCx0CE: Interrupts-Masked Cycles with Interrupt Pending  
 679 PMCx0CF: Interrupts Taken  
 679 PMCx0D0: Decoder Empty  
 679 PMCx0D1: Dispatch Stalls  
 679 PMCx0D3: Microsequencer Stall due to Serialization  
 679 PMCx0D5: Dispatch Stall for Instruction Retire Queue Full  
 679 PMCx0D6: Dispatch Stall for Integer Scheduler Queue Full  
 679 PMCx0D7: Dispatch Stall for FP Scheduler Queue Full  
 679 PMCx0D8: Dispatch Stall for LDQ Full  
 680 PMCx0D9: Microsequencer Stall Waiting for All Quiet  
 680 PMCx0DB: FPU Exceptions  
 680 PMCx0D[F:C]: DR[3:0] Breakpoint Matches  
 680 PMCx1C0: Retired x87 Floating Point Operations  
 681 PMCx1CF: Tagged IBS Ops  
 681 PMCx1D0: Retired Fused Branch Instructions  
 681 PMCx1D8: Dispatch Stall for STQ Full  
 681 PMCx1DD: Cycles Without Dispatch Due To Integer PRF Tokens  
 681 PMCx1DE: Cycles Without Dispatch Due to FP PRF Tokens  
 681 PMCx1DF: FP Dispatch Contention  
 682 NBPMCx0E4: Memory Controller Bypass Counter Saturation  
 682 NBPMCx0E8: Thermal Status  
 683 NBPMCx0E9: CPU/IO Requests to Memory/IO  
 683 NBPMCx0EA: Cache Block Commands  
 684 NBPMCx0EB: Sized Commands  
 684 NBPMCx0EC: Probe Responses and Upstream Requests  
 685 NBPMCx1E0: CPU to DRAM Requests to Target Node  
 685 NBPMCx1E1: IO to DRAM Requests to Target Node  
 686 NBPMCx1E2: CPU Read Command Latency to Target Node 0-3  
 686 NBPMCx1E3: CPU Read Command Requests to Target Node 0-3  
 686 NBPMCx1E4: CPU Read Command Latency to Target Node 4-7  
 687 NBPMCx1E5: CPU Read Command Requests to Target Node 4-7  
 687 NBPMCx1E6: CPU Command Latency to Target Node 0-3/4-7  
 688 NBPMCx1E7: CPU Requests to Target Node 0-3/4-7  
 688 NBPMCx1EB: Request Cache Status 1  
 688 NBPMCx1F0: Memory Controller Requests  
 689 NBPMCx3EC: DRAM Accesses  
 689 NBPMCx3ED: DRAM Controller Page Table Overflows  
 690 NBPMCx3EE: Memory Controller DRAM Command Slots Missed  
 690 NBPMCx3EF: Memory Controller Turnarounds  
 690 NBPMCx3FC: DRAM Accesses  
 691 NBPMCx3FD: DRAM Controller Page Table Overflows  
 691 NBPMCx3FE: Memory Controller DRAM Command Slots Missed  
 691 NBPMCx3FF: Memory Controller Turnarounds